

Manuel Ortega

804 South Bluebonnet

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EXECUTIVE SUMMARY

This paper outlines the plan for fulfilling the USDA APHIS goal of preventing screwworm from re-colonizing the United States in the most efficient and cost-effective manner possible.

SIX YEAR ACTION PLAN FOR THE APHIS SCREWORM PROGRAM

April 02, 1991

EXECUTIVE SUMMARY

This paper outlines the plan for fulfilling the USDA APHIS goal of preventing screwworms from re-entering the United States in the most efficient and cost-effective manner possible.

The plan includes three major interrelated components:

- 1) Establish a sustainable, stationary barrier in Panama.**
- 2) Retain the current production facility in Tuxtla Gutierrez, Chiapas, Mexico, as the sole source of sterile flies until a production facility is operating in Panama.**
- 3) Organize for an effective and efficient screwworm eradication program in Central America.**

GOAL

The goal of the USDA APHIS Screwworm Program is to prevent screwworms from re-entering the United States and other eradicated countries.

BACKGROUND The major mission of APHIS is the protection of the United States agricultural industry from foreign diseases and pests. Agriculture is the single largest industry in the United States and livestock production is the industry's largest component. Based on cash receipts, the livestock sector accounts for 55 percent of the total value of agriculture in the United States, not including the 40 percent of the plant sector dedicated to the production of animal feeds. An animal or animal product is the leading agricultural commodity in 34 of the 50 states.

The screwworm fly, *Cochliomyia hominivorax* (Coquerel), historically has been one of the most serious livestock pests, as well as a threat to humans, wildlife and other domestic animals. Adult flies lay eggs near open wounds; larvae that develop in these wounds cause serious injury and death if not treated.

Eradication of screwworms in the United States was one of the most significant animal health activities in the history of the livestock industry. It is estimated that screwworm eradication has saved producers, consumers and taxpayers hundreds of millions of dollars per year in terms of increased productivity and lower consumer prices. Eradication also has allowed significant changes to occur in livestock management and production; such as, a reduced need for labor in identifying and treating screwworm cases and an expansion of the livestock breeding season into spring and summer months when screwworm flies were most prevalent. Reintroduction and

establishment of screwworms would have a devastating effect on livestock production and marketing.

To reduce the risk of screwworms entering the United States from Mexico, APHIS initiated a program with Mexico in 1972 to create a barrier at the Isthmus of Tehuantepec. This highly successful program achieved that barrier in 1984; however, large movements of cattle from infested to eradicated areas proved to be an unacceptable risk. A moving eradication zone has progressed southward and currently is located in Belize and Guatemala. This moving barrier has accomplished the program goal of keeping screwworms out of the United States and Mexico.

This action plan is driven by the need to establish a sustainable barrier which can be maintained at minimal cost and provide an acceptable level of security to the United States and Mexico. At the same time, budget limitations and demands for greater accountability require a search for the most efficient and economical method to administer the program and to produce and disperse sterile flies.

In creating this plan, a number of assumptions were made about factors outside the program's control. These assumptions and more detailed economic analyses are contained in the Appendix. With these attendant uncertainties in mind, planning for the Screwworm Program takes on an even greater importance.

ISSUE 1. ESTABLISHING A BARRIER

ISSUE At present there is no permanent, sustainable screwworm barrier. The active eradication zone functions as a barrier as it moves south. Currently, the eradication zone has moved through Mexico and now lies within Guatemala and Belize. Selecting and establishing a stationary barrier at a strategically sound location will provide the most cost effective solution for protecting the livestock industry.

DISCUSSION In 1966 USDA declared the United States free of self-sustaining screwworm populations. At that time, it was considered sufficient to release sterile flies along the Mexico-United States border. The failure of this barrier in 1972 taught that the security a barrier provides is directly proportional to its distance from the United States and inversely proportional to its surface area. Shortly thereafter, APHIS signed an agreement with Mexico with the objective of eradicating screwworms to the narrowest part of Mexico, the Isthmus of Tehuantepec, and establishing a stationary barrier at that point.

When screwworms were eradicated to the Isthmus in 1984, it became obvious that a stationary barrier at this location would not be effective for two reasons. First, the large number of cattle produced in the Yucatan Peninsula and transported both legally and illegally into areas north of the Isthmus posed a high risk of continuously re-infesting screwworm-free areas. Second, the division created between livestock producers in the eradicated north and the infested south was politically unacceptable to Mexico.

Officials concluded that not only was a permanent barrier at the Isthmus of Tehuantepec costly and risky, but also it was not feasible to divide the country in half.

Sterile fly production accounts for over 50 percent of direct program costs; the smaller the land mass to be covered, the fewer flies need to be produced. Possible barrier or pause points included the Isthmus of Tehuantepec; the border between Guatemala, El Salvador and Honduras; Costa Rica; and the Darien Gap in Panama. An economic analysis in 1985 concluded that the most cost effective barrier would be located at the Darien Gap in Panama, the narrowest connection between the continents of North and South America. Panama was therefore selected as the most desirable site, with Costa Rica as an alternative location. Eradication activities have already moved into the Yucatan Peninsula, Guatemala and Belize in 1985, 1987 and 1989 respectively.

The major difficulty in completing eradication to Panama is a "hump" in dispersal levels of 262 million sterile flies per week for operations along the Honduras and Nicaragua border (see Table 1). When El Salvador and Honduras are eradicated, dispersal levels progressively decrease through Nicaragua and Costa Rica to 40 million sterile flies per week at Panama. The program conceivably can pause at any point but would require additional funding to sustain needed dispersal levels over larger geographical areas.

OBJECTIVE 1. By 1996 establish a permanent stationary barrier in Panama.

ACTION STEP	PRODUCT	RESPONSIBLE	DATE (q/yr)*
1. Negotiate agreements with: -El Salvador and Honduras -Nicaragua -Costa Rica -Panama --New Plant & Barrier --Eradication	Agreements with individual countries	DAIS **	2nd/91 4th/91 1st/92 *** 1st/94
2. Assess environmental impact	Environmental Impact Statement	DAIS	If and When Required
3. Discuss plan with USAID to obtain PL 480 funding for Central American Countries	Funding Commitment	DAIS/FAS	To be determined
4. Implement organizations for Central America and Panama	Infrastructures established	Regional Director	As scheduled
5. Conduct field operations (eradication, surveillance, quarantine, control, and support) to establish the barrier	Barrier established	Regional Director	1st/91 through 4th/96

* q=quarter, yr=year

** Deputy Administrator, International Services/APHIS

*** Informal communication with Panama indicates a willingness to accept both a production facility and a permanent barrier.

ISSUE 2. INFRASTRUCTURE FOR PRODUCING STERILE FLIES

ISSUE The screwworm production facility located in Tuxtla Gutierrez, Chiapas, Mexico, is the only functioning plant of its kind in the world. Deficiencies in the plant's physical condition have reached the point where a significant, continued commitment of funds is required to ensure reliable production of sterile flies to reach and establish a barrier in Panama. Renovations are also required to incorporate technological changes in rearing methods developed since the plant was built in 1973. Probable budgets through Fiscal Year 1996 do not include sufficient funds to meet all these needs at one time.

Long-term sustained production for barrier maintenance in Panama requires a new facility located close to the barrier. The size of such a facility would be appropriate for the required dispersal of 40 million sterile flies per week. The facility at Tuxtla Gutierrez, designed to produce 500 million sterile flies per week, cannot be operated in a cost-effective manner at 8% of capacity.

DISCUSSION Reliable sterile fly production is necessary to safeguard progress to date and to advance into Central America. Deficiencies in the Tuxtla Gutierrez rearing facility include a wide variety of significant cost items.

The total cost for bringing the facility up to standard is approximately \$13 million. A contribution from FAO of \$1.6 million for renovation will be used to support the eradication effort in North Africa.

The program strategy of establishing the barrier in Panama, combined with budget limitations, requires that repairs and replacements are systematically and consistently carried out. The current best estimate is that approximately \$3.0 million is required annually. These funds will be needed regardless of the eradication zone's location and for as long as the Tuxtla Gutierrez plant is in operation.

Upon reaching Panama, the most cost effective method of providing flies for barrier maintenance is through a new rearing facility located close to the barrier. Although extensive design for a facility in Panama was completed in 1987, the design criteria and cost estimates must be revised to reflect current program planning and new technologies. Since additional USDA funds probably will not be available for a new plant, alternative sources of funding and organizational relationships should be explored including leasing arrangements or other private market solutions. Discussions toward the identification of private contract and funding sources must be initiated soon.

CURRENT STATUS A new supply water treatment plant is in operation which should significantly reduce further wear on water conducting components of the Heating Ventilation and Air Conditioning (HVAC) system. The water distribution system is being reviewed and repaired to reduce water loss. The next step will be to address mechanical deficiencies of the HVAC system. The facility must be able to meet a field need of 262 million insects per week by the first quarter of 1992.

ISSUE 3. ORGANIZING FOR EFFECTIVE AND EFFICIENT SCREWORM ERADICATION IN CENTRAL AMERICA

ISSUE Future APHIS screwworm eradication activities in Central America will be cooperative efforts between the United States and each cooperating country with sterile flies being provided by the Mexico-United States Commission for the Eradication of Screwworms. This creates the need to restructure the Commission; organize efficient and effective program operations in each host country; and, ultimately, barrier maintenance operations in Panama.

DISCUSSION Since the inception of screwworm eradication efforts in Mexico in 1972, activities in that country have been bilaterally managed through the Mexico-United States Commission. The nature of this Commission will change as APHIS moves into Central America. The Commission will provide sterile flies for the USDA eradication effort in Central America. Mexico will assume prevention and surveillance responsibilities once screwworms become an exotic pest in that country.

One of the critical challenges facing APHIS is the need to design and implement an organizational structure to best meet program needs in the new operational environments. The Central American countries are geographically small,

their national budgets lack the resources to finance the program directly and the eradication efforts in any one country are not expected to last more than two to three years. These factors require a well coordinated APHIS program and host country structures that can best accommodate the varying operational conditions on a country-by-country basis.

Once screwworm eradication is accomplished, the remaining host country's infrastructure must conduct prevention and surveillance activities and future animal and plant health activities.

In order to establish a permanent barrier in Panama, a new rearing facility will need to be brought on line for three reasons. First, maintaining a rearing facility in the eradicated zone will present an unacceptable risk due to the presence of fertile material; second, field operational costs would be significantly higher utilizing the existing facility due to the need to transport sterile pupae to Panama; and third, operational costs would be significantly higher operating the existing facility at only 8% of capacity. APHIS will need to work with Mexico and USAID to find an alternate use for the old facility and alternate employment opportunities.

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APPENDIX

Economic and Production Considerations

I. Introduction

This section contains a more detailed discussion of the production and economic calculations and assumptions of the APHIS Sterileworm Plan.

II. Program Model

A. Barrier Location

The goal of the Sterileworm Program is to prevent screwworms from re-entering the United States and other eradicated countries. Selection of a sterile fly barrier location is based on two criteria: (1) the relative degree of risk versus the location provided; and (2) the cost of maintaining the barrier. The more distant the barrier, the lower the risk of screwworm re-invasion to eradicated country. Total program cost is a function of the land surface area the barrier must cover, sterile fly transportation and dispersal, labor, and materials. Generally, surface area is the most important factor determining total barrier cost.

The program's original goal was to establish and maintain a sterile fly barrier at the Isthmus of Tehuantepec, approximately 300 miles in width. The introduction of new technology, such as a genetic based diet and a low-free adult dispersal system, will enable the barrier to move to a more cost effective location farther north.

A barrier at the Isthmus of Panama (southern of Panama City, near the Darien Gap) excludes the security of the

United States against screwworm re-infestation and minimizes the long-term cost of maintaining the barrier and the program as a whole. A 1985 study of the "Barrier location problem" concluded Panama is clearly the optimal location among the available sites in Central America. Costa Rica is the second most favorable location for a barrier and a future sterile fly production facility; however, Costa Rica's mountain ranges add a significant element of risk to the task of aerially releasing flies to maintain the barrier. The size of the barrier needed in Costa Rica would require 40 million sterile flies per week, fifty percent more than in Panama (40 million sterile flies per week). As the population effort proceeds north, it provides a moving barrier that could be maintained at any given location if the program had to stop for any reason. Clearly, however, maintaining a barrier north of Panama is logistically, financially and politically more difficult to sustain.

B. Program Model

Table 1 shows a sterile fly dispersal plan for the Central American countries which would give certain assumptions, eradicate screwworm from the area by 1995. The plan provides for a gradual buildup of sterile fly releases over a six-month period for each country with the exception of El Salvador, one calendar year of full dispersion (3,000 sterile flies weekly per square mile), and then a six-month wind-down period. Sterile flies will be flown from the current facility in Tuxtla Gutierrez, Chiapas, Mexico, to the active eradication area. Table 1 shows that the number of sterile flies needed to maintain this plan peaks in approximately 262 million males per week in the last quarter of the second year (the first quarter of 1992 if the program proceeds on schedule).

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Economic and Production Considerations

I. Introduction

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II. Program Model

A. Barrier Location

The goal of the Screwworm Program is to prevent screwworms from re-entering the United States and other eradicated countries. Selection of a sterile fly barrier location is based on two criteria: (1) the relative degree of risk/security the location provides; and, (2) the cost of maintaining the barrier. The more distant the barrier, the lower the risk of screwworms re-entering an eradicated country. Total program cost is a function of the land surface area the barrier must cover, sterile fly transportation and dispersal, labor, and materials. Generally, surface area is the most important factor determining total barrier cost.

The program's original goal was to establish and maintain a sterile fly barrier at the Isthmus of Tehuantepec, approximately 200 miles in width. The introduction of new technology, such as a gelatin based diet and a box-free adult dispersal system, will enable the barrier to move to a more cost effective location further south.

A barrier at the Isthmus of Panama (southeast of Panama City, near the Darien Gap) maximizes the security of the

United States against screwworm re-infestation and minimizes the long-term costs of maintaining the barrier and the program as a whole. A 1985 study of the "barrier location problem" concluded Panama is clearly the optimal location among the available sites in Central America. Costa Rica is the second most favorable location for a barrier and a future sterile fly production facility: however, Costa Rica's mountain ranges add a significant element of risk to the task of aerially releasing flies to maintain the barrier. The size of the barrier needed in Costa Rica would require 60 million sterile flies per week, fifty percent more than in Panama (40 million sterile flies per week). As the eradication effort proceeds south, it provides a moving barrier that could be maintained at any given location if the program had to stop for any reason. Clearly, however, maintaining a barrier north of Panama is logistically, financially and politically more difficult to sustain.

B. Program Model

Table 1 shows a sterile fly dispersal plan for the Central American countries which would, given certain assumptions, eradicate screwworms from the area by 1996. The plan provides for a gradual buildup of sterile fly releases over a six-month period for each country with the exception of El Salvador, one calendar year of full dispersion (3,000 sterile flies weekly per square mile), and then a six-month wind-down period. Sterile flies will be flown from the current facility in Tuxtla Gutierrez, Chiapas, Mexico, to the active eradication area. Table 1 shows that the number of sterile flies needed to implement this plan peaks at approximately 262 million insects per week in the first quarter of the second year (the first quarter of 1992 if the program proceeds on schedule).

C. Budget Analysis

Table 2 provides a detailed breakdown of the anticipated costs for one year of an eradication program in each of the Central American countries. Overhead costs are not included. A key factor is the distance of each country from Tuxtla Gutierrez and the anticipated pupae transport and air dispersal costs. Twin engine aircraft are required to disperse sterile flies throughout Central America (with the possible exception of Panama, an additional costs advantage). Such aircraft cost twice as much per hour as the single engine aircraft previously used by the Commission. Table 3 provides a breakdown of the anticipated costs of the program through 1996.

Table 4 presents the costs of maintaining a barrier at the Isthmus of Tehuantepec. Maintaining a barrier at this location would entail significantly higher costs compared to Panama. A barrier at Tehuantepec cannot be sustained through 1996 with current funding; a budget increase of approximately \$7 million annually (30% more than current spending) would be needed to maintain a barrier that would provide significantly less security to the United States livestock industry and its consumers than a barrier anywhere else in Central America.

III. Assumptions

A. The Program's Real Dollar Budget Will Decline

The real dollar budget (i.e., the net funds available to the field, corrected for inflation) will decrease. This will occur as the inflation rate in the Central American countries (estimated at 6% after factoring in changes in exchange rates) outstrips the assumed 3 percent annual inflationary

increase in funds available to the field. Given the U.S. government's current fiscal condition, no additional increases in program funding can be expected.

B. Appropriated Funds For A New Production Plant Will not be Available

No money is expected to be available from appropriations in the immediate future to build a new sterile fly rearing plant. Furthermore, it was assumed that no funds will be available from other sources to support the program directly.

C. The Current Facility Will Produce Sufficient Sterile Flies To Support the Program

The program may be continued using pupae transported by air from the Tuxtla Gutierrez plant. Although this has some risks such as the risk of having the plant in a screwworm-free area, lack of infrastructure in the eradicated countries and costly long-distance air transport, it is clearly feasible, both technically and economically. A new facility will be required in Panama eventually.

D. Returning the Barrier to the Isthmus of Tehuantepec is the Least Preferred Alternative

By the end of Fiscal Year 1991, the program will be releasing sterile flies over all of Guatemala and Belize. Returning the barrier to the Isthmus of Tehuantepec would sacrifice the gains made since 1986. It would also be impossible to sustain the program at current funding because returning to Tehuantepec would require rebuilding the extensive and expensive field staff for surveillance in Mexico. A preferred alternative would be to create an interim barrier in Honduras and El Salvador.

E. Agreements are Signed on Schedule and No Other Significant Delays Occur

The program model assumes that agreements with the Central American countries will be signed on schedule. Delays in obtaining these agreements will lengthen the program and increase costs. Delays caused for other reasons (e.g., any interruption of sterile fly production) would have the same impact.

F. The Program Will Be Led By APHIS

To achieve eradication in the area by 1996 it is essential that APHIS operate the program cooperatively with the various host country governments. As noted in the Plan, the Mexico-United States Commission will continue to provide sterile flies for the program.

G. Administrative Cost Savings Will Be Achieved

Program funding is assumed to decline in real dollars (e.g., "constant dollars", or face value of funding corrected for inflation to show buying power in 1990 dollars) available to the field. It will be necessary to make significant savings in areas such as purchasing and personnel if anticipated funding is to provide adequate resources for a Central American program. Without such savings, the funds available in the first 2 years will be insufficient to run the program as planned (Table 3). The Planning Team believes that these savings can be achieved.

H. Significant Outbreaks are Paid Through Emergency Funds

The anticipated budget outlined in Table 3 contains no contingency funds to eradicate large outbreaks in screwworm-free areas. These funds would have to be provided from other sources to keep the program operating within its budget and on schedule.

I. This Plan is Initiated During Fiscal Year 1991

It is essential that this entire program be initiated without delay and be carried out according to the recommended schedule. If major delays are encountered or unexpected budget reductions occur, the final goal will not be met.

Table 1. Sterile Fly Disposal needs by country for eradicating screwworm from Central America

Country	1974				1975				1976				1977				1978				1979			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Guatemala	40	40	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
El Salvador	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Honduras	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Nicaragua	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Costa Rica	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Panama	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

TABLES AND FIGURES

Table 1. Projected screwworm program cost by country 1/

Table 1. Sterile fly dispersal needs by country for eradicating screwworm from Central America

Country	Year and Quarter																							
	1991				1992				1993				1994				1995				1996			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	millions of flies per week																							
Mexico	40	40	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Guatemala	115	115	115	115	90	60	30																	
Belize	24	24	24	24	18	12	6																	
Honduras			30	60	120	120	120	120	60	30														
El Salvador			24	24	24	24	24	24	12	6														
Nicaragua						30	60	125	125	125	125	60	30											
Costa Rica											15	30	60	60	60	60	30	15						
Panama														20	40	80	80	80	80	40	40	40	40	
Total	179	179	203	233	262	226	220	214	207	171	150	165	130	100	90	110	120	105	90	90	50	50	50	50

2/ Based on air transport of pupae from Tuxtla Gutierrez, Mexico, to a packaging center in each country. Number of pupae shipped weekly during peak dispersal periods and air miles from Tuxtla Gutierrez to packaging centers as follows: Belize--4 million pupae/week, 261 miles; Guatemala--115 million pupae/week, 281 miles; Honduras--120 million pupae/week, 415 miles; El Salvador--14 million pupae/week, 305 miles; Nicaragua--125 million pupae/week, 491 miles; Costa Rica--60 million pupae/week, 675 miles; Panama--60 million pupae/week, 1,004 miles.

3/ Cost of operating packaging centers to box bulk pupae for air dispersal.

Table 2. Projected screwworm program cost by country 1/

Cost Item	Country						
	Belize	Guatemala	Honduras	El Salvador	Nicaragua	Costa Rica	Panama
	Millions of 1991 U.S. dollars						
Fly Diet	0.5	2.5	2.6	0.5	2.7	1.3	1.7
Pupae Transport 2/	0.2	0.8	0.9	0.2	1.2	0.7	1.1
Air Dispersal	0.7	3.5	3.7	0.7	3.8	1.8	2.5
Boxes	0.2	0.9	0.9	0.2	0.9	0.4	0.6
Packaging 3/	0.1	0.3	0.3	0.1	0.3	0.1	0.2
Field Operations	0.5	1.5	1.5	0.5	2.0	1.0	1.5
Total	2.2	9.4	9.9	2.2	11.0	5.4	7.5

1/ Cost in constant dollars (1991 US\$) for direct program costs for each country for one year.

2/ Based on air transport of pupae from Tuxtla Gutierrez, Mexico, to a packaging center in each country. Number of pupae shipped weekly during peak dispersal periods and air miles from Tuxtla Gutierrez to packaging centers as follows: Belize--24 million pupae/week, 281 miles; Guatemala--115 million pupae/week, 281 miles; Honduras--120 million pupae/week, 410 miles; El Salvador--24 million pupae/week, 305 miles; Nicaragua--125 million pupae/week, 491 miles; Costa Rica--60 million pupae/week, 678 miles; Panama--80 million pupae/week, 1,004 miles.

3/ Cost of operating packaging centers to box bulk pupae for air dispersal.

Table 3. Projected funding, expenses and surplus/shortfall by year for Screwworm Eradication Program in Central America 1/

	1991	1992	1993	1994	1995	1996	Total
----- millions of 1991 U.S. dollars -----							
SOURCES OF FUNDS							
Mexico	3.5	3.6	3.7	3.8	3.9	4.1	22.6
United States	28.1	29.2	30.1	31.0	31.9	32.9	183.6
Total	31.6	32.8	33.8	34.8	35.9	37.0	206.2
EXPENSES							
80/20 Budget							
Administration	1.3	1.0	0.5	0.0	0.0	0.0	2.8
Field Operations	3.3	0.0	0.0	0.0	0.0	0.0	3.3
Production	8.5	9.0	9.6	10.1	10.7	11.4	59.3
Air Operations	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Subtotal	13.2	10.0	10.1	10.1	10.7	11.4	65.5
Country Programs							
Mexico	0.9	0.2	0.2	0.3	0.3	0.3	2.2
Belize	2.2	0.9	0.0	0.0	0.0	0.0	3.1
Guatemala	9.4	3.8	0.0	0.0	0.0	0.0	13.2
El Salvador	1.1	2.3	0.5	0.0	0.0	0.0	3.9
Honduras	1.9	10.5	2.1	0.0	0.0	0.0	14.4
Nicaragua	0.0	2.2	12.3	2.4	0.0	0.0	16.9
Costa Rica	0.0	0.0	1.1	6.4	1.3	0.0	8.9
Panama	0.0	0.0	0.0	1.7	9.5	5.0	16.2
Subtotal	15.5	19.8	16.2	10.8	11.1	5.3	78.8
Support Budget							
U.S. Support	5.2	5.6	5.9	6.2	6.6	3.5	33.0
Plant Maintenance	0.5	0.5	0.5	0.5	0.5	0.5	3.0
Air Supervision	0.1	0.1	0.1	0.1	0.1	0.0	0.4
Mission Plant	0.2	0.2	0.2	0.2	0.2	0.2	1.1
Subtotal	6.0	6.3	6.6	7.0	7.4	4.3	37.6
GRAND TOTAL	34.6	36.1	32.9	28.0	29.2	21.0	181.8
YEAR-END BALANCE	(3.1)	(3.3)	0.9	6.9	6.7	16.0	24.4

1/ Eradication schedule as shown in Appendix Tables 1 and 2; permanent stationary barrier established in Panama in 1986. Figures rounded to nearest 100,000. Projections reflect a 3% yearly increase due to inflation.

Table 4. Projected funding, expenses, and surplus/shortfall by year for establishing and maintaining sterile-fly barrier at the Isthmus of Tehuantepec, Mexico 1/

	1991	1992	1993	1994	1995	1996	Total
----- millions of 1991 U.S. dollars -----							
SOURCES OF FUNDS							
Mexico	3.5	3.6	3.7	3.8	3.9	4.1	22.6
United States	28.1	29.2	30.1	31.0	31.9	32.9	183.6
Total	31.6	32.8	33.8	34.8	35.9	37.0	206.2
EXPENSES							
80/20 Budget							
Administration	1.5	1.6	1.7	1.8	1.9	2.0	10.5
Field Operations	10.0	10.6	11.3	12.0	12.7	13.4	70.1
Production	11.8	12.5	13.2	14.0	14.9	15.8	82.1
Air Operations	4.5	4.8	5.1	5.4	5.7	6.0	31.4
Subtotal	27.8	29.5	31.3	33.1	35.1	37.2	194.1
Support Budget							
U.S. Support	5.2	5.6	5.9	6.2	6.6	7.0	36.6
Plant Maintenance	0.5	0.5	0.5	0.5	0.5	0.5	3.0
Air Supervision	0.1	0.1	0.1	0.1	0.1	0.1	0.4
Mission Plant	0.2	0.2	0.2	0.2	0.2	0.2	1.1
Subtotal	6.0	6.3	6.6	7.0	7.4	7.8	41.1
GRAND TOTAL	33.8	35.8	37.9	40.1	42.5	45.0	235.2
YEAR-END BALANCE	(2.1)	(2.9)	(4.1)	(5.3)	(6.6)	(8.1)	(28.9)

1/ Re-establishing a permanent sterile fly barrier at the Isthmus of Tehuantepec and maintaining it there indefinitely. Funding assumes 3% annual increase for inflation. Figures are rounded to nearest 100,000.

SCREWWORM ERADICATION IN CENTRAL AMERICA

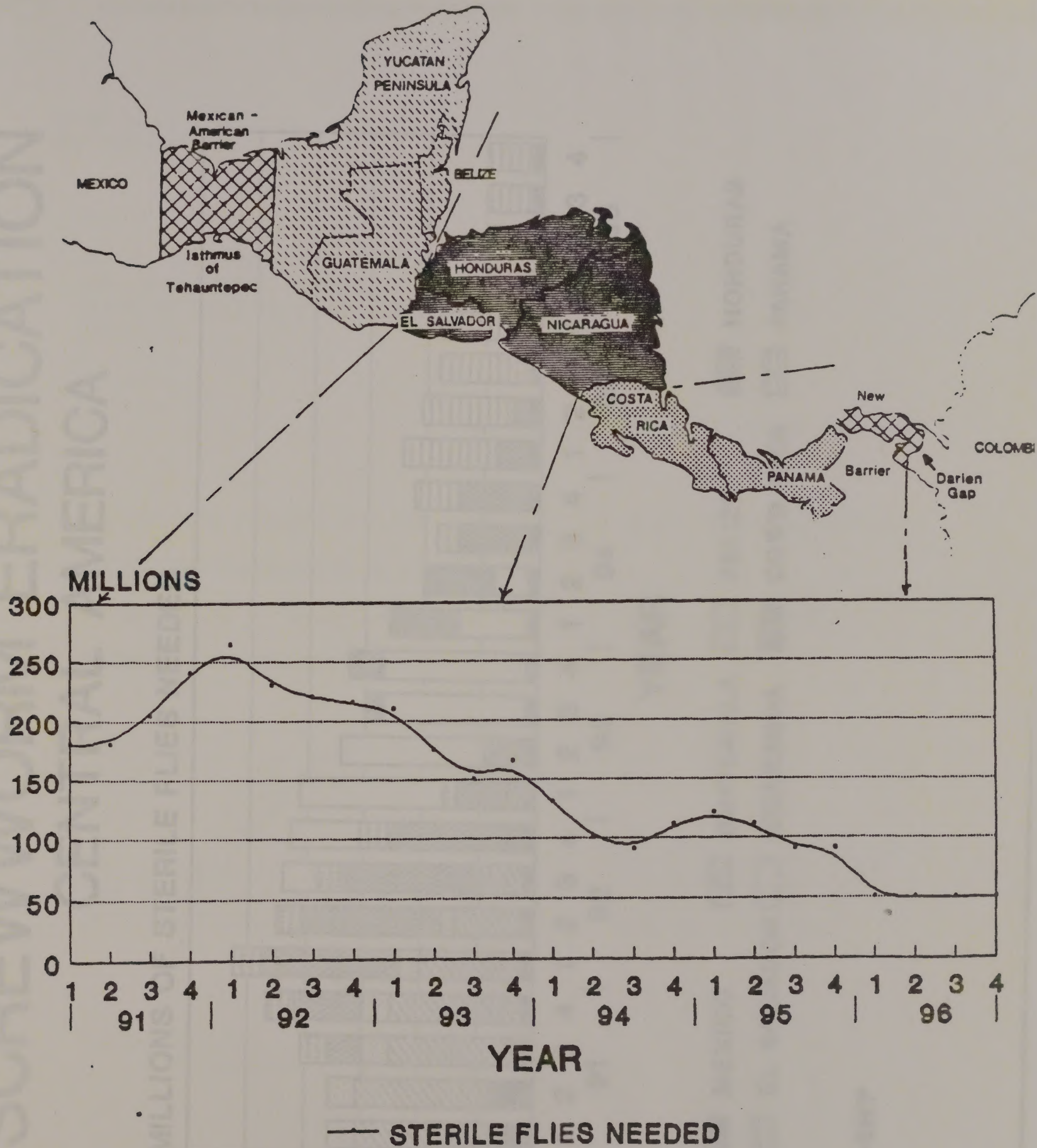
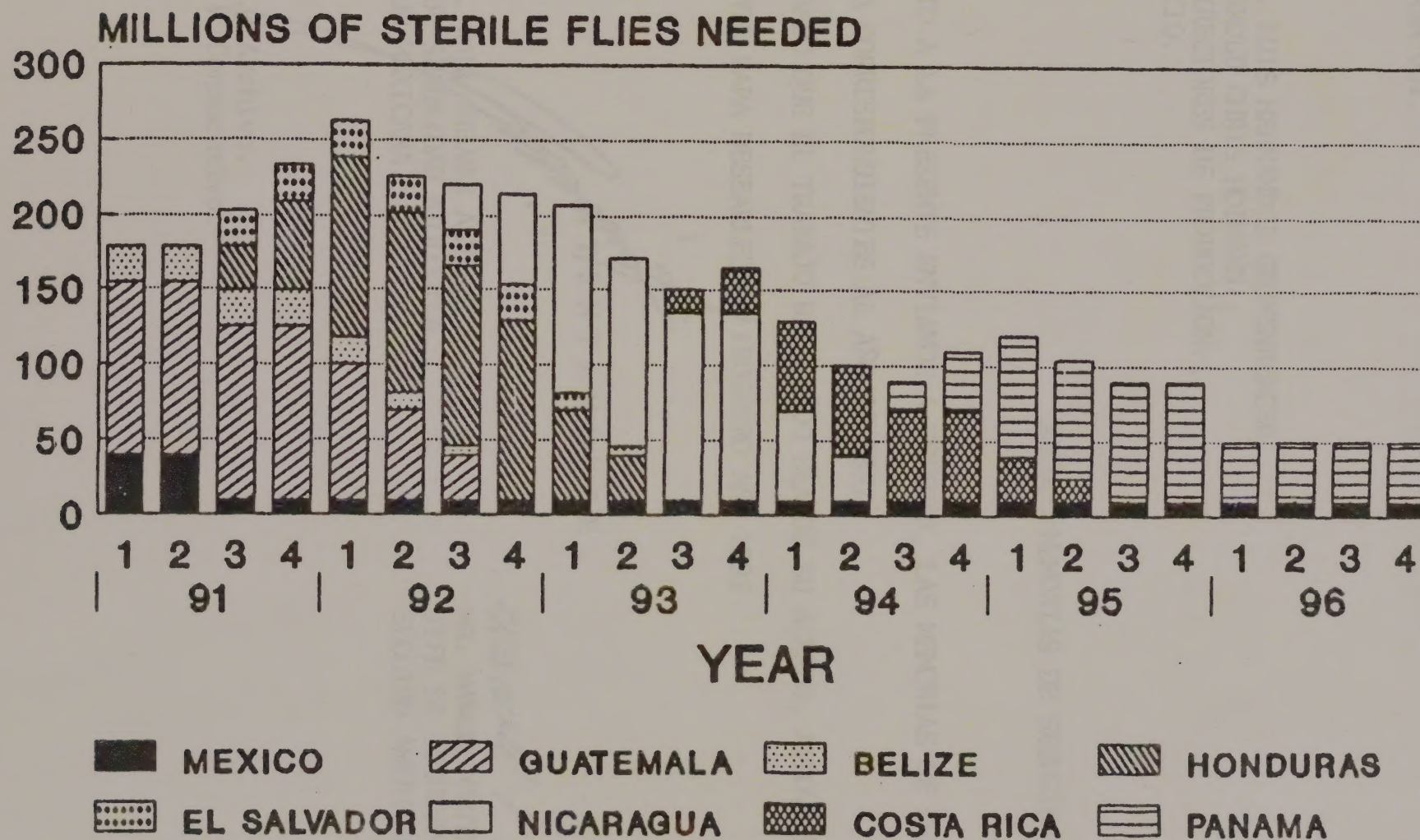


Fig. 1. Relationship between eradication zones and the number of sterile insects required to reach pause/barrier points.

SCREWWORM ERADICATION CENTRAL AMERICA



APHIS-IS-SWP



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

ENERO 02 DE 1992.
REF:USB*RSA*001.

A: M.V.Z. LUIS HERNANDEZ GRUNENBERGER.,
DR. HAROLD CHRIS HOFMANN.,
SUB*DIRECTORES DE PRODUCCION.,
EDIFICIO.

ASUNTO:MEMORIAS DE SEGURIDAD BIOLOGICA.

ADJUNTO A LA PRESENTE ENVIAMOS A USTEDES, LAS MEMORIAS DE SEGURIDAD BIOLOGICA CORRESPONDIENTES AL AÑO DE 1991.

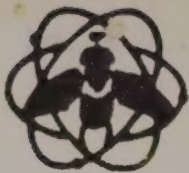
ESPERANDO QUE EL TRABAJO REALIZADO SEA DE SU AGRADO, APROVECHAMOS LA --
PRESENTE PARA DESEARLES UN PROSPERO AÑO 1992.

ATENTAMENTE .

M.V.Z. RAUL SELVAS ALVAREZ.,
JEFE DE SEGURIDAD BIOLOGICA,
SECCION MEXICANA.

Manuel Ortega
MR. MANUEL ORTEGA.,
JEFE DE SEGURIDAD BIOLOGICA,
SECCION AMERICANA.

C.c.p. Archivo.
Consecutivo.



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

PLANTA PRODUCTORA DE MOSCAS ESTERILES

SEGURIDAD BIOLOGICA.

1.0.- ANTECEDENTES DE 1990.

Para un control eficiente y evitar escape de material biológico fértil de G.B.G. del área crítica de la Planta, durante el año de 1990 se continuó reforzando con nuevos proyectos, equipo y procedimientos aplicados en las posibles vías de escape del insecto fértil.

También se continuó evaluando la aplicación de éstos, a través del Monitoreo con Trampas para captura de moscas y Corrales con borregos heridos instalados en los terrenos de la Planta y zonas aledañas. Obteniendo como resultado al cierre de ese año, 443 días sin coleccionar masas de huevecillos normales de G.B.G.

2.0.- MEMORIAS MENSUALES 1991.

2.1.1.- E N E R O.

- Aún con las limitaciones de personal y equipo en Seguridad Biológica, existe optimismo para continuar con el éxito obtenido a finales del año anterior.

- Continúan siendo relevantes los trabajos de la impermeabilización de la azotea de la Planta, con una supervisión continua para evitar fuga de material biológico fértil.

- Se observa constante taponamiento en las mallas de retención larvaria, sistema utilizado para tratar las aguas residuales generadas en el área crítica. Al respecto se solicita al Departamento de Producción mejorar el procedimiento de vaciado de desechos de las charolas cuyos residuos al efectuar el lavado de las mismas ocasiona dicho taponamiento.

- También existe obstrucción continua en los filtros del sistema de Inyección de Vapor que se utiliza para tratar los desechos de gel water-lock. Se solicita mayor supervisión para evitar que el personal obrero arroje guantes y otros objetos a los desechos y que Ingeniería y Mantenimiento realice sondeo antes de iniciar el paso de desechos de gel.

- Se determina y aprueba orden de trabajo para habilitar un espacio en área del antiguo Cuarto de Algodón para que funcione como Laboratorio de identificación de Seguridad Biológica.

- Problema grave que se presenta durante éste mes es el incremento de mosca libre de G.B.G. en el área crítica, que aunado a la remodelación efectuada en los casilleros generales del interior, se observa migración de mosca a ésta área.

#2.....

Se toman las siguientes medidas preventivas:

- a).- Cambios continuos de fly-catchers en áreas problemas.
- b).- Se aprueba construcción de un Laberinto Interior con Tapete Sanitario entre el área de Piso de Produccion y Casilleros Generales.

2.1.2.- F E B R E R O.

- Siguen aplicandose medidas preventivas para controlar la mosca libre de G.B.G. y migración de la misma hacia casilleros generales y baños del interior, por lo que a partir del 5 de Febrero se cancela temporalmente el uso de la puerta de acceso general del área crítica, utilizandose la puerta de salida para ambos fines.

- Se instalan cortinas nuevas de vinil en las diferentes áreas del Interior de la Planta.

- Se efectúa libranza y reparación del cuarto caliente "E" . Se repara sistema de alumbrado e inyección de vapor.

- Suprimen temporalmente el cambio de garrafones de agua potable que se efectúa a través del área de visitantes para evitar posible fuga de mosca fértil de G.B.G.

- Se lleva efecto en el área crítica campaña para combatir roedores.

- Para optimizar la liberación terrestre de mosca irradiada se construye bases de concreto a nuestras cámaras de emergencia ubicadas en los terrenos de la Planta.

- Durante éste mes continúan los trabajos pendientes de Seguridad Biológica:

- a).- Laberinto Interior.
- b).- Impermeabilización de la Azotea.
- c).- Laboratorio de Identificación.

2.1.3.- M A R Z O.

- Se lleva efecto libranza del cuarto caliente "S" y se repara también la inyección de vapor y sistema de alumbrado.

- Finaliza la construcción del Laberinto Interior con resultados muy buenos ya que se evita la migración de mosca libre de G.B.G. hacia casilleros generales del Interior y baños de visitantes. Considerando lo anterior se permite utilizar nuevamente la puerta de acceso general del área crítica y el cambio de garrafones de agua potable a través del área de visitantes.

- Es crítica la carencia de tambos metálicos para tratar los desechos sólidos generados en el área crítica y que se eliminan a través de Cuartos calientes.

- Por problemas con el equipo que registra la temperatura en el Sistema de Inyección de Vapor que se usa para tratar los desechos de gel water-lock, se presenta una fuga a través de éste equipo, el día 6 de Marzo. Las larvas fértiles de G.B.G. fugadas fueron sacrificadas y controladas por personal de Seguridad Biológica.

- Por lo acontecido y mencionado en el punto anterior se lleva a efecto junta extraordinaria del Comité de Seguridad Biológica tomándose los siguientes acuerdos:

- a).- Se determinan los procedimientos para tratar los desechos de Gel-Water-Lock tanto en el Interior como en el Exterior, asimismo la responsabilidad operacional de los Departamentos involucrados.
- b).- Que Ingeniería y Mantenimiento elabore un manual técnico de procedimientos para tratar los desechos de Gel Water-Lock y preserve la Seguridad Biológica de la Planta.
- c).- Se solicita a Ingeniería y Mantenimiento agilizar la importación e instalación de los nuevos inyectores de vapor que se hayan en Laredo, Texas.
- d).- Adquirir e instalar una centrífuga.
- e).- Que el Departamento de Desarrollo de Métodos investigue la posibilidad de utilizar un estrusor similar al usado en Metapa, Chis., por Moscamed.

- Continúan los trabajos de impermeabilización de la azotea, habilitación del nuevo Laboratorio de Identificación de Seguridad Biológica y Tapete Sanitario Interior.

2.1.4.- A B R I L .

- Inicia el mes observandose baja temperatura en el cuarto caliente "S", por lo que Seguridad Biológica determina someter por más días los tambos con desechos en dicho cuarto. Lo anterior provoca mayor crisis en la carencia de tambos y se solicita a Ingeniería y Mantenimiento agilizar la reparación, misma que se realiza a mediados del mes.

- Se observa incremento de mosca libre de G.B.G. en el Almacén Interior por el material acumulado y contaminado con larvas y pupa. Se solicita apoyo a los Departamentos involucrados y se efectúa limpieza del área obteniendo como resultado el control de la mosca libre.

- El Departamento de Ingeniería realiza pruebas para tratar de suprimir la aplicación de cloruro de calcio a los desechos de gel que se eliminan a través del Inyector de Vapor. Los resultados son negativos por lo que se solicita a éste mismo Departamento la fabricación de un dosificador de cloruro de calcio.

- En el transcurso de éste mes vuelven a realizar pruebas con el mismo fin, probando bombas de mayor capacidad siendo los resultados positivos y razón por la que se suspende la fabricación del dosificador de cloruro de calcio.

- Se suspende la instalación del Tapete Sanitario en el Laberinto Interior por cierta inconformidad manifestada por el personal obrero. El Comité acordó que se investigue otras alternativas de solución.

- Para finalizar el mes se observa un incremento en la mosca libre de G.B.G. en el área de Piso de Producción, debido a que la larva con caída prematura de precámara adquiere mejor viabilidad pupando y emergiendo en esa área. Para control se solicita al Departamento de Producción mejorar la colecta larvaria y limpieza.

- Continúan los trabajos de impermeabilización de la azotea de la Planta y construcción del Laboratorio de Identificación sin que acontezcan riesgos a la Seguridad Biológica.

2.1.5. - M A Y O.

- Siguen presentandose en el área crítica de la Planta problemas para controlar la mosca libre de G.B.G; el Departamento de Producción sigue apoyando y tratando de mejorar la colecta larvaria y limpieza del área de Piso. Asimismo se solicita a Ingeniería y Mantenimiento que en coordinación con Seguridad Biológica revise y repare mallas y ducterías deterioradas del Sistema de Inyección y Extracción de Aire.

- Sigue observandose deterioro y carencia de tambos metálicos para tratar los desechos sólidos generados en el área crítica de la Planta.

- Se genera orden de trabajo para construir una caseta enmallada en la azotea de la Planta y evitar posibles fugas de material biológico fértil a través del equipo de recirculación del aserrín que proviene del separador de Pupa-Aserrín del área crítica.

- Ingresan al área crítica los nuevos Inyectores de Vapor, e inician adaptaciones en el área de centrífugas para instalarlos.

- Casi finalizan los trabajos de la Impermeabilización de la azotea y el Laboratorio de Identificación lleva un avance del 60%.

2.1.6. - J U N I O.

- Inicia el mes teniendo como punto relevante la obra terminada Impermeabilización de la Azotea de la Planta por la Compañía CIMAC., y recibida el 10. de Junio de 1991 por el Departamento de Ingeniería y Mantenimiento, cabe observar que en el contrato con ésta compañía no estaba incluido impermeabilizar el techo del área de Colonia II, misma que será restaurada por Ingeniería y Mantenimiento.

- Se efectúa inspección de la azotea y se generan órdenes de trabajo para reparar equipos y ducterías dañados por obras de impermeabilización. Ingeniería y Mantenimiento procede a parchar unicamente ductería podrida debido a la falta de personal y material.

- Se realiza campaña para combatir roedores en el área crítica de la Planta.

- Finaliza modificación de una sección del área de Piso de Producción, quedando pendiente pintar el piso y fabricación de anaqueles que se usarán en esta nueva área.

- Finaliza en azotea el enmallado del equipo de recirculación de aserrín.
- Continúa observandose bastante mosca libre de G.B.G. en el área de Piso de Producción por lo que el Comité acordó:
 - a).- Darle mantenimiento a todos los insectronics del área crítica y -- reparar los que están sin reparar.
 - b).- Implementar en la colecta larvaria el uso de aspiradoras y carri-- tos colectores para optimizarla.
 - c).- Agilizar la adquisición de pintura y fabricación de anaqueles para la nueva área de piso.
 - d).- Reparar mallas y ductos podridos de los extractores de aire tam-- bién del área de Piso de Producción.
- Continúa observandose carencia de tambos metálicos para los cuartos ca-- lientes; se rescatan 15 tambos del Taller Automotriz.

2.2.0. - R E S U M E N S E M E S T R A L.

Al finalizar el semestre, Seguridad Biológica efectúa análisis de tra-- bajos pendientes y prioritarios siendo los siguientes:

- 1.- Laboratorio de Identificación de Seguridad Biológica= 95% de avance
- 2.- Instalación de los nuevos Inyectores de Vapor= 10% de avance.
- 3.- Tapete Sanitario para Laberinto Interior=Pendiente.
- 4.- Adquisición de pintura para la nueva área de Piso de Producción = s haya en Laredo, Texas.
- 5.- Implementar la aspiración en la colecta larvaria de Producción=Real zandose ajustes técnicos a las aspiradoras y carritos adquiridas pa ra ese fin.
- 6.- Fabricación de anaqueles que se usarán en la nueva área de Piso de Producción= 25% de avance.
- 7.- Habilitación del nuevo cuarto de iniciación= Finalizan los trabajos por el Exterior, falta romper pared de concreto Interior aplicandos medidas preventivas determinadas por Seguridad Biológica.
- 8.- Deficiencia de tambos metálicos usados en cuartos calientes.
- 9.- Determinar proyecto para eliminar los desechos de gel water-lock ge nerados en el área de Cambio de Cepa.
- 10.- Cambio total de ductería podrida de Inyectores y Extractores de Air del área crítica de la Planta.

2.2.1. - J U L I O.

- Finaliza la obra para adaptar un área del antiguo Cuarto de Algodón que fungirá como Laboratorio de Identificación de Seguridad Biológica, ocupandose para las actividades propias del monitoreo con trampas y corrales.

- Se autoriza la solicitud para comprar 100 tambos metálicos nuevos que - sustituirán a los tambos deteriorados usados en el área de Cuartos Calientes para- tratar los desechos sólidos generados en el área crítica de la Planta.

- Debido a los paros sindicales acontecidos durante éste mes, el avance de trabajos pendientes de Seguridad Biológica es casi nulo. Concretándose el personal de la Unidad a las actividades rutinarias y apoyar en sus labores al Departamento de Producción.

2.2.2. - A G O S T O .

- Se realizan ajustes a las instalaciones del Laberinto Interior, solicitado por la Comisión Mixta de Seguridad e Higiene para comodidad del trabajador adscrito al área crítica. Se eliminan dos entrepaños y cortinas de vinil intermedias de dicho Laberinto.

- Durante éste mes se observan bastantes problemas con el equipo usado para movilizar los desechos de Cuartos Calientes hacia los Depósitos Terrestres.

- Se acordó en junta de Seguridad Biológica que el Departamento de Métodos e Ingeniería se pongan en contacto con técnicos de MOSCAMED y ver la posibilidad de probar el Estruder que ellos ofrecieron facilitar temporalmente para tratar los desechos de gel generados en el área de Cambio de Cepa.

- Se autoriza la solicitud de compra para adquirir nuevos y diferentes tipos de recipientes para tratar y movilizar los desechos sólidos en el área de Cuartos Calientes.

- Poco avance en los trabajos pendientes de Seguridad Biológica por parte de Ingeniería y Mantenimiento, debido al inicio tardío a sus labores y huelga de brazos caídos del personal sindicalizados.

2.2.3. - S E P T I E M B R E .

- Se normaliza el checado de tarjeta de asistencia por parte del personal sindicalizado .

- Se continúa pintando el suelo de la nueva área de Piso de Producción.

- Se le dá mantenimiento a los Cuartos Calientes.

- Los días 20 y 27 de Septiembre el Departamento de Ingeniería realiza pruebas con los nuevos Inyectores de Vapor con resultados negativos y propiciando la fuga de larvas fértiles de G.B.G. a través de los desechos de gel. Personal de Seguridad Biológica controla y trata al material fértil sacrificando las larvas con diesel.

- Durante éste mes se observa poco avance en los trabajos pendientes de Seguridad Biológica por parte de Ingeniería y Mantenimiento persistiendo los mismos problemas del mes anterior.

2.2.4. - O C T U B R E .

- A principio de éste mes finalizó la aplicación de la pintura epoxica en la nueva área de Piso de Producción.

- El Departamento de Producción empieza a usar la nueva área de crecimiento larvario, observandose migración de la misma hacia el Laberinto Interior por lo que se agilizó la implementación de la aspiración en la colecta larvaria para optimizarla, también se realizan canales de Retención Larvaria al inicio y final del Laberinto Interior con resultados bastantes positivos evitandose la migración larvaria de G.B.G.,* ésta última acción suple la construcción del Tapete Sanitario.

- Se vuelve a presentar el 10 de Octubre fuga larvaria de G.B.G., a través del nuevo Inyector de Vapor, propiciado por las pruebas que realiza el Departamento de Ingeniería con ese equipo. Personal de Seguridad Biológica sacrifican y controlan la fuga larvaria. Cabe observar que todas las pruebas realizadas durante éste mes con ese equipo dan resultados negativos.

- Se designa a Mr. Manuel Ortega como Jefe de Seguridad Biológica por la Sección Americana.

- Se detecta y colecta bastante mosca en las rejillas interior del extractor AE-II que está sin funcionar. Se observa al microscópio la mosca, determinandose que procede del exterior del área crítica y se genera orden de trabajo para cambiar toda la ductería podrida del extractor en la azotea de la Planta y el área de Piso Interior de Producción.

- Se toman las medidas preventivas de Seguridad Biológica para romper la pared de concreto interior donde se instalará la puerta del nuevo cuarto de iniciación de Producción.

- Durante éste mes persistieron los problemas de falta de tambos metálicos para tratar los desechos sólidos en cuartos calientes. Se observa poco avance en la solicitud de compra de los mismos.

2.2.5. - N O V I E M B R E .

- Considerando que las fugas larvarias de G.B.G. suscitadas en el mes de Octubre fueron causadas por el Departamento de Ingeniería y Mantenimiento al probar los nuevos Inyectores de Vapor, el Comité de Seguridad Biológica gira las siguientes condiciones para que dicho Departamento pueda continuar con sus pruebas:

a).- Primero lo probarán con agua sin contaminación de material biológico fértil de G.B.G.

b).- Si es positivo el resultado de la prueba anterior se hará con gel nuevo también sin contaminación de material biológico.

c).- Si los resultados continúan siendo positivos se probarán con desechos de gel y material biológico.

d).- Compromiso de Ingeniería y Mantenimiento que en todas las pruebas mencionadas no haya fuga de material biológico fértil de G.B.G.

* Durante éste mes Ingeniería suspende las pruebas con éste equipo.

- Se efectúa cambio parcial de la ductería podrida del Extractor AE-II, se determina también que el cambio total de equipo y ductería del Sistema de Inyección y Extracción de Aire de la Planta, se llevará a efecto el próximo año, considerando que dicho material y equipo le llega al Departamento de Ingeniería en el mes de Enero de 1992.

- Finaliza la habilitación del nuevo cuarto de iniciación, observandose que al ser usado por el Departamento de Producción se incrementa el número de larvas de G.B.G. tiradas en el suelo, mismas que caen al efectuar la alimentación y realimentación a las charolas que las contienen y que se lleva a efecto a un lado de dicho cuarto.

Para evitar la pupación y emergencia de esa larva por el Almacén Interior, Seguridad Biológica solicita la ejecución de las siguientes órdenes de trabajo:

a).- Instalar canales de retención larvaria en las puertas de acceso al Almacén Interior.

- b).- Reforzar con insectronics el área de riesgo.
- c).- Reubicar cortinas de vinil en el pasillo interior de Cuartos-- Calientes.
- d).- Cambiar hules de empaque a las puertas de Cuartos Calientes y-- tambien colocar pasadores nuevos a éstas puertas que con la -- diferencia de presión de aire se entreabren.

- Persisten los problemas en los cuartos calientes por la deficiencia de tambos metálicos para tratar los desechos.

2.2.6.- D I C I E M B R E .

- Se observa deterioro en las instalaciones del Nuevo Cuarto de Ini-- ciación ("D") por lo que se acordó tenerlo en observación y que el sello de ma-- dera exterior unicamente se quite cuando haya completa seguridad en la preserva-- ción de Seguridad Biológica. También se determina usar plastilina térmica para-- sellar las rendijas de las paredes del cuarto.

- Se instalan los canales de retención larvaria en las puertas de - - acceso al Almacén Interior, así también 6 insectronics distribuidos en esa área con el fin de evitar la migración larvaria y emergencia de G.B.G.

- Ingresan al Almacén General 100 tambos metálicos nuevos, mismos que sustituirán a tambos muy deteriorados y usados para tratar y movilizar los de-- sechos sólidos generados en el área crítica y eliminados a través de los Cuar-- tos Calientes.

- Durante éste mes se ejecuta un proyecto de remodelación en el área-- de centrífugas para implementar un sistema de vaciado de desechos de gel water-- lock a través de una jaula aérea giratoria conteniendo al anaquel con las charo-- las de desecho. Asimismo se efectúan ajustes a las instalaciones de los Inyecto-- res de Vapor, los cuales se probarán en el mes de Enero de 1992, para determi-- nar de acuerdo a los resultados si continúan controlandose por computadora o -- manualmente.

3.0.0.- O B S E R V A C I O N E S .

- En el registro de éstas memorias se citaron unicamente los puntos -- relevantes acontecidos, con la observancia que la Unidad siempre realizó y estuvo atenta a que se cumplieran con los procedimientos y actividades rutinarias esta-- blecidas y regidas por la Legislación de Seguridad Biológica.

- Así también se continuó evaluando durante todo el año la preserva-- ción de Seguridad Biológica a través de las trampas de captura de moscas y corra-- les con borregos heridos monitores.

* Al respecto se anexan cuadros y gráficas con dicha información.

4.0.0.- CONCLUSIONES.

- Trabajando conjuntamente con los Departamentos involucrados se logró controlar y evitar la fuga de material biológico fértil viable de la Planta, no obstante el riesgo persiste.

La mosca libre de G.B.G. en las diferentes área del interior de la Planta continúa siendo el mayor riesgo para preservar Seguridad Biológica. Así también las acciones realizadas para su control no han sido del todo eficientes debido a que siempre se ha tratado de evitar la migración y fuga de la mosca mas no se ha corregido el origen de la misma.

- De la ductería del sistema de inyección y extracción de aire, en 1988- señalamos que era necesario su reemplazo total, hasta la fecha no se hizo y se ha continuado remendando con los riesgos posibles.

- Con respecto al sistema para eliminar las aguas residuales del área crítica, sigue utilizandose la malla inclinada de retención larvaria, con una eficiencia aceptable mientras se usó dieta hidropónica en el área de crecimiento larvario, pero al cambiar el soporte de la dieta a gel water-lock se observa constante taponamiento de la malla inclinada y también desprendimientos laterales de la misma, ocasionando riesgos a la Seguridad Biológica. Es urgente implementar otro sistema que minimise los riesgos y la mano de obra.

- La eliminación de los desechos sólidos generados en el área crítica y eliminados a través de cuartos calientes continúa siendo bastante eficiente; se optimizó cuando se redujo el volumen de desechos gracias al cambio de la dieta larvaria de hidropónico a gel water-lock, así también a que la temperatura registrada en los cuartos calientes durante éste año fué bastante aceptable.

* El principal problema que adolece en ésta área es la de recipientes y equipo adecuado para tratar y movilizar los desechos sólidos tanto en el interior como exterior de la Planta. Lo que se usa actualmente para ese fin es completamente obsoleto.

- Al efectuarse el cambio de soporte en la dieta de G.B.G., se generó otra vía posible de escape de material biológico fértil a través del Sistema de Inyección de Vapor, que se implementó para eliminar los desechos de gel water-lock. El resultado obtenido con dicho sistema ha sido bastante irregular, ya que las fugas larvarias que se presentaron éste año fueron a través del mismo.

Asimismo es necesario que el Departamento de Ingeniería y Mantenimiento efectúe lo más pronto posible ajustes técnicos a éste sistema para disminuir los riesgos a Seguridad Biológica y si el resultado obtenido es satisfactorio, implementar éste sistema en el tratamiento y eliminación de las aguas residuales de la Planta, suprimiendo así el uso del sistema de mallas de retención larvaria-

- El control en la entrada y la salida del personal al área crítica, continúa siendo eficiente usandose para ese fin puertas independientes.

5.0.0.- RECOMENDACIONES.

Para dar continuidad al éxito obtenido es necesario:

- Implementar un sistema para mejorar la colecta larvaria de G.B.G., -- optimizar el sacrificio de moscas contenidas en las jaulas que fueron sometidas a oviposición, con el fin de disminuir considerablemente la mosca libre de G.B.G., en el área crítica de la Planta.

- Agilizar y ejecutar el proyecto para reemplazar totalmente la ductería y equipo del sistema de Inyección y Extracción de Aire de la Planta.

- Suprimir y sustituir el sistema de mallas de retención larvaria mismo que actualmente resulta obsoleto

- Implementar otro tipo de recipientes y equipo para tratar y movilizar los desechos sólidos que se eliminan a través de Cuartos Calientes.

- Instalar y habilitar los nuevos Inyectores de Vapor.

- Establecer y definir el método que se utilizará para eliminar los desechos de gel water lock en el área de Cambio de Cepa, del Departamento de Investigación y Desarrollo Experimental.

6.0.0.- R E S U L T A D O S.

" Bastante exitoso y optimista ya que el 31 de Diciembre de 1991, se -- cumplen 2 años con 78 días sin que se presente ningún caso positivo a G.B.G. - en la Planta y zonas aledañas.

CUADRO No. 1

SEGURIDAD BIOLÓGICA
=====

COLECTA MENSUAL DE MASAS DE HUEVECILLOS DE G.B.G.
ENERO A DICIEMBRE DE 1991.

<u>M E S</u>	<u>No. M A S A S</u>	<u>E S T E R I L</u>	<u>F E R T I L</u>
ENERO	0	0	0
FEBRERO	0	0	0
MARZO	0	0	0
ABRIL	0	0	0
MAYO	0	0	0
JUNIO	0	0	0
JULIO	0	0	0
AGOSTO	0	0	0
SEPTIEMBRE	0	0	0
OCTUBRE	0	0	0
NOVIEMBRE	0	0	0
DICIEMBRE	0	0	0
T O T A L =	0		

S E G U R I D A D B I O L O G I C A

= = = = =

CAPTURA MENSUAL DE MOSCAS DE G . B . G .

ENERO A DICIEMBRE DE 1991.

<u>M E S</u>	<u>M.T.D.</u>
ENERO	69.79
FEBRERO	69.44
MARZO	86.11
ABRIL	94.24
MAYO	117.17 *1
JUNIO	56.32
JULIO	22.52 *2
AGOSTO	72.54
SEPTIEMBRE	63.20
OCTUBRE	34.90
NOVIEMBRE	28.16
DICIEMBRE	31.84

(X) M.T.D. ANUAL= 62.18

O B S E R V A C I O N E S .-

- *1= Incremento en el M.T.D. , debido a que Región "B" dispersó 1056 cajas de -- mosca irradiada en Hot-spot, exedente que se liberó en la Planta además del programa establecido de dispersión.
- *2= Decremento en el M.T.D. por prueba especial de selección de colores, con -- trampas instaladas acerca de nuestras cámaras de emergencia por A.R.S.
- Durante éste año unicamente se capturó una mosca fértil (2-X-91), conside-- randose un caso aislado ya que no se manifestó en las heridas de los borre-- gos monitores.

S E G U R I D A D B I O L O G I C A

= = = = =

CAPTURA MENSUAL DE MOSCAS DE G.B.G. IRRADIADAS QUE PRESENTAN ESTADIOS OOGENICOS AVANZADOS.

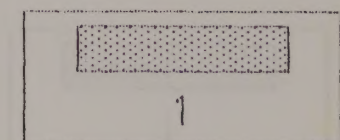
ENERO A DICIEMBRE DE 1991.

<u>M E S</u>	<u>No. MOSCAS</u>
ENERO	0
FEBRERO	0
MARZO	2
ABRIL	0
MAYO	0
JUNIO	0
JULIO	0
AGOSTO	0
SEPTIEMBRE	0
OCTUBRE	2
NOVIEMBRE	0
DICIEMBRE	0
T O T A L=	4

O B S E R V A C I O N E S .-

- Decreció notablemente el número de moscas irradiadas con desarrollo oogénico avanzado con relación al año de 1990 (85 Moscas).

9



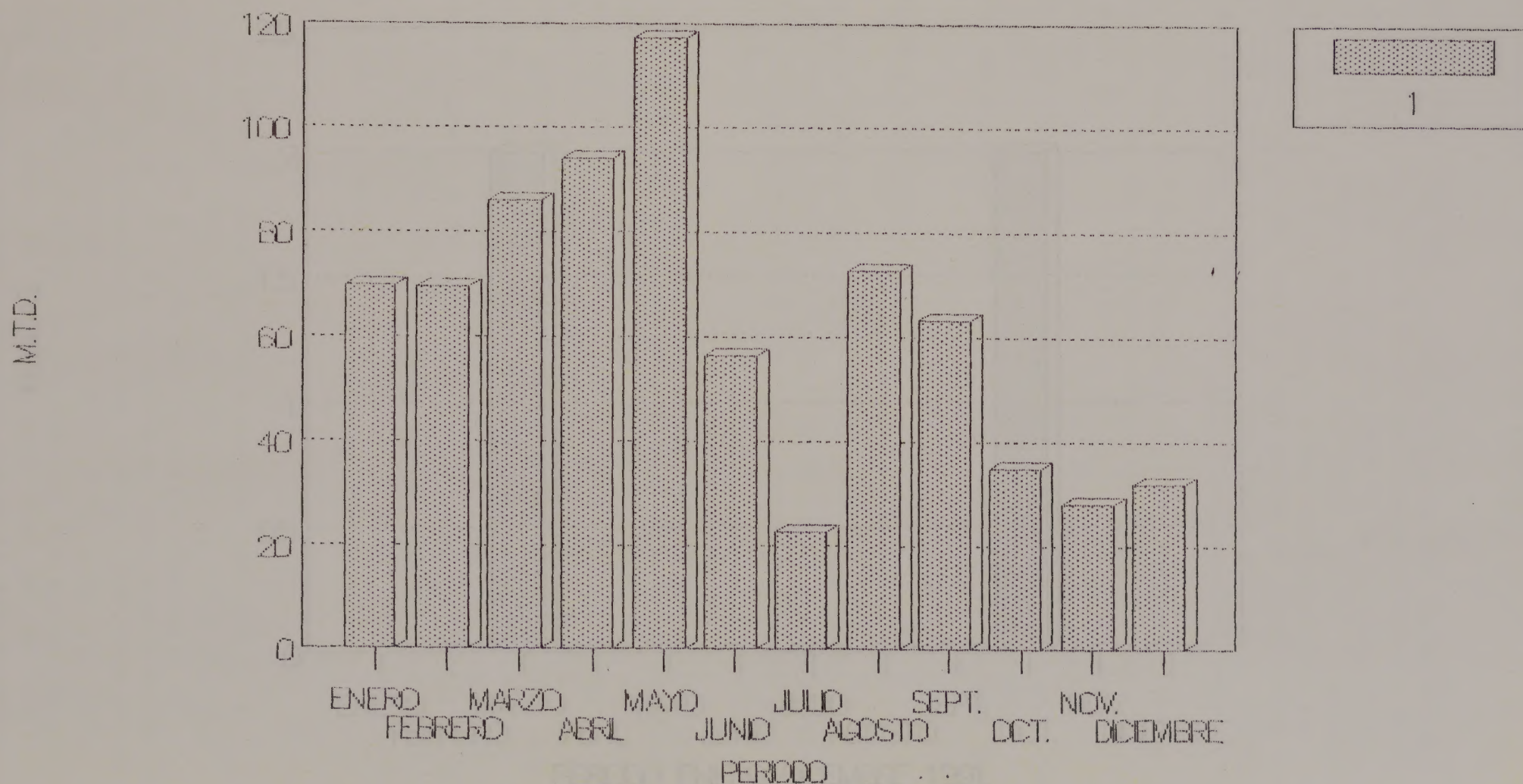
0 —————

ENERO MARZO MAYO JULIO SEPT. NOV.
FEBRERO ABRIL JUNIO AGOSTO OCT. DICIEMBRE

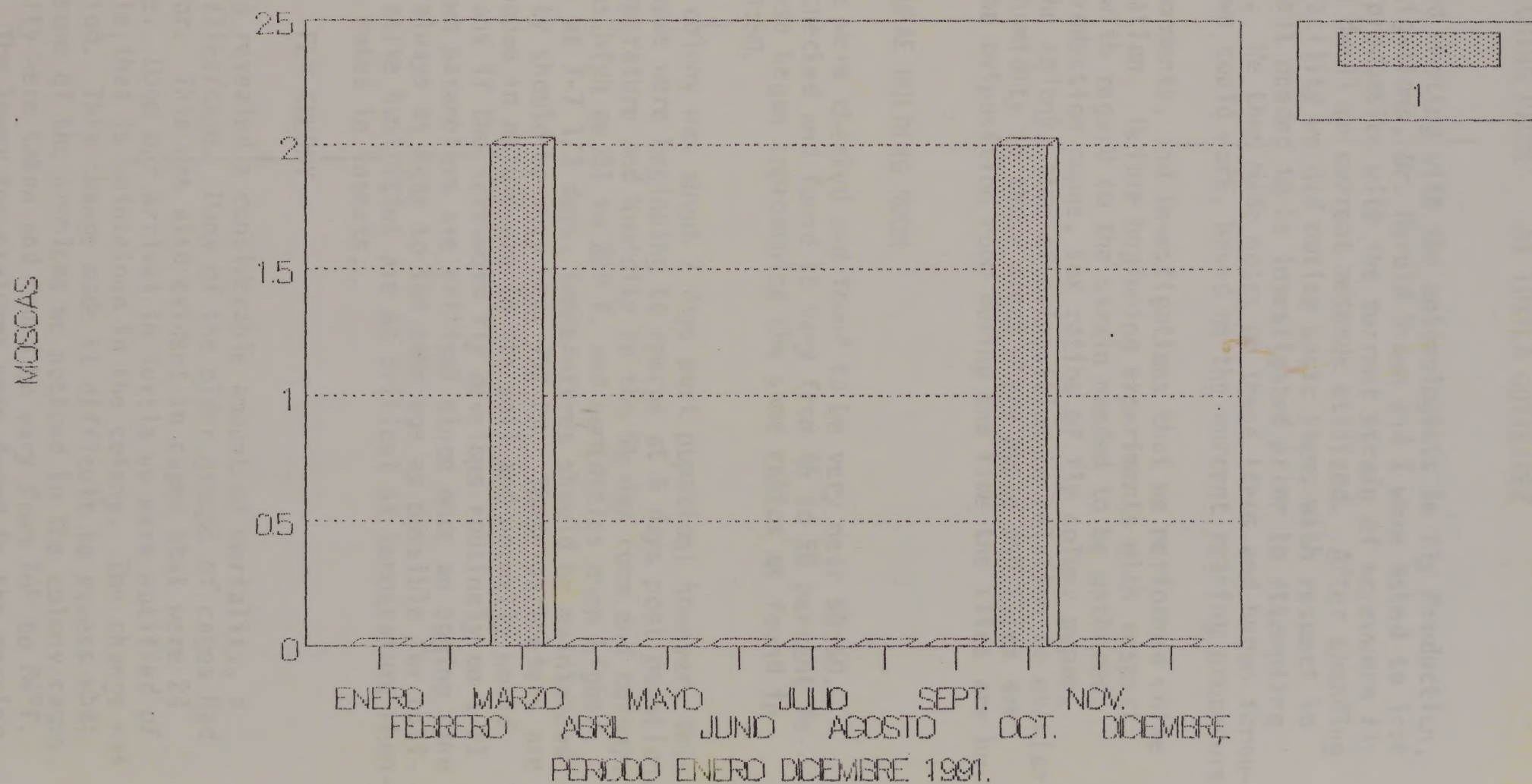
PERIODO ..

CAPTURA MOSCAS G.B.G.

CON ENERO A DICIEMBRE DE 1991.



CAPTURA MOSCAS G.B.G. IRRADIADAS CON ESTADIOS OOGENICOS AVANZADOS.



INVESTIGATION OF EGGING PROBL: AT TUXTLA GUTIERREZ

Upon our arrival in Tuxtla and meeting with the entomologists in Fly Production, prior to beginning our investigations, Dr. Harold Brown and I were asked to look for new ways to increase egg production with the current strain of screwworm fly in mass production and not to dwell on current methods utilized. After spending several days in the rearing facility we did notice basic items with respect to insect mass rearing that we felt needed to be investigated prior to attempting to answer the eggging problems. We then made notes on these items and began formulating criteria within which we could work, based on the current rearing procedure.

The following observations, comments, and investigations that we performed while in Tuxtla are for your information. Before beginning experiments with respect to eggging, basic information with regard to the strain needed to be gathered. These include sex ratios of production pupae, sex ratios of fly colony pupae, mortality of these flies in the colony, time of oviposition in relation to ovarian development, temperature and humidity in those areas where pupae and flies are held, and the conditions in the oviposition room during the time the flies are being eggged.

PUPAE HOLDING ROOM

Sex ratios of production pupae were checked and found to be very near 50:50. Colony pupae sex ratios were checked and found to vary from 46 to 56 percent female. Several days later, these began approaching the same ratios as found in the production pupae, i.e., 50:50.

Emergence of the pupae in the colony was about 7 days post pupation; however, this varied and oftentimes these pupae were beginning to emerge at 6 days post pupation. This can be related to the temperature and humidity in the 5½ day room and colony. Temperatures at times ranged as high as 81 to 82° F. and humidities even higher. Generally, to effect emergence at 7-7 1/3 days, temperatures should be maintained at 78° F ± 1. Relative humidity should be very near 75% RH. These parameters are critical if we consider that pupae in nature are in the soil and normally would not experience great fluctuations if the screwworm fly develops routinely on a 21 day life cycle. Also, these two parameters are critical since once an eggging time is established, the flies are always as near to the same age as possible for optimum oviposition. Elevated relative humidities are as critical as temperature whenever we consider developmental rates in insects.

FLY COLONY

Early observations in this area revealed a considerable amount of mortality, a minimum of about one liter of flies/cage. Many of the older groups of cages had eggs deposited on the cage floor. This was also evident in cages that were 24 hours prior to oviposition time. Upon our arrival in Tuxtla we were notified of a change in the light:dark cycle that is maintained in the colony. The change was made to a 14:10 (L:D) photoperiod. This change made it difficult to assess what exactly may have been causing some of the problems we noticed in the colony cages. Temperature and relative humidity were taken and found to vary from 78° to 84°F. and 52 to 60% RH respectively. The lower temperatures were found in the morning,

and as outside conditions warmed so did the colony. These higher temperatures continued for as much as 8 hours throughout the day. Continuous exposures to temperatures in this range will cause increased fly activity, both physical and biochemical, resulting in increased mortality and advanced ovarian development.

Daily, samples of flies were taken from the six oldest groups of flies in the colony to determine the amount of ovarian development in these flies. We found that the ovarian development was advanced 16 to 24 hours. Many of the flies showed yolk resorption was occurring even in the younger groups. This suggested that these flies were being stressed somewhere during the time they were in the colony. Two factors may cause this: (1) sustained elevated temperatures causing increase in fly activity both physically and physiologically as mentioned earlier, (2) reduced food availability to meet this increased activity. This phenomenon of yolk resorption occurred approximately in 10 to 50% of the flies that we dissected.

With respect to the second, problems were noted with the flowability of the honey in the chick feeders. This is evidenced by very little drop in honey level in the jars, and physically handling the honey. With 6 pint jars of honey that do not adequately allow carbohydrate uptake by the flies, most flies are forced to feed on the honey-meat mixture. The amount of food available on three trays of honey/meat decreases as this mixture dehydrates.

Normally, with flies held in cages of this density and in a photoperiod of 14:10 (L:D), sex ratios of the dead flies in the cages are 65 to 70 percent male and 35 to 30 percent female. Cages that were sampled eight hours prior to oviposition had female mortalities averaging 57 percent. This reversal in sex ratio mortality may be attributed to the stress being applied to the flies. Since vitellogenesis, or the process of yolk deposition, is an energy requiring metabolic process, these females are in a weakened condition since the carbohydrate source is not readily available to support energy requirements. As long as the males continue to harass the females with mating strikes, the females eventually are required to use protein as evidenced by yolk resorption for basic metabolism which in insects indicates they are in a reduced state of fitness. Ultimately the insects die, and in this case the females are the majority of the insects found in the bottom of the cages.

OVIPOSITION ROOM

Room temperatures in the oviposition room varied throughout the day. Temperatures ranged from 78 to 84° F., all of which are acceptable; however, one critical condition that was not, or can not be controlled, is the relative humidity in the oviposition room. Relative humidities ranged from 53 to 78 percent RH whenever these were checked at random times throughout the day. It has been found by working with new strains that optimum temperature and relative humidity in the oviposition room are essential to optimize oviposition. This will be discussed in the section on egg production cages in Methods Development. The cotton used on the egg production vats as opposed to sponge, may serve as well as the sponge; however, it is very important that this material be placed carefully on the vats so that the entire egg production board is in contact with the cotton. It is very important that the wet/dry interface [egg production board (dry) cotton or sponge (wet)] be continuous the entire length of the egg production board. It was noticed that whenever the cotton was not packed down smoothly, the flies only deposited eggs

wherever the eggging boards were in contact with the cotton. This seemingly insignificant item is very important to the female, particularly if we consider where egg masses are deposited in nature on a wounded animal. The vat temperature and resulting surface temperature of the sponge or cotton with attractant is also very critical. This temperature requirement varies with each strain of fly that is introduced; particularly with strains that are relatively new. The eggging boards, three individual 2x2's, seem to be satisfactory if these are placed on the vats so that the previously mentioned criteria are met. Additional boards on the side of the eggging vat would improve the collection of extra eggs from these cages in two ways. Generally most of the eggs are deposited on the darker side of an oviposition device; therefore, additional eggging space in this area should aid in collecting larger quantities of eggs, particularly since the flies were ovipositing on the metal portions of the vat. Secondly, boards on the edges of the vats also increases the area for the flies to oviposit by 25 percent, or 20 grams of eggs based on cages obtaining 80 grams of eggs without the boards.

The response of the flies to the eggging device seemed to be adequate; however, the flies would not stay around the boards after the light intensity around the device was decreased. Several factors may contribute to this phenomenon. First the vat temperature may not be suitable for the fly. The Sinaloa strain prefers vat surface temperatures around 98° F. If eggging devices are placed into cages of flies without being warmed to the proper temperature, the flies will not stay around the vat once the light intensity is turned down. With the current procedures of eggging cages during daylight hours, some vats are not ready to be placed in the cages. Only one hour is available for some vats to be removed from a cage, cleaned, attractant and cotton applied before the vat is again used in a cage. More vats are needed so that proper preparation and warm up can be accomplished prior to reuse in a cage for oviposition. Also, these vats could be checked to see if they are working properly.

Many female flies were seen resting on the curtains adjacent to the eggging vat. These curtains extended below the vat surface and may be a physical barrier to the flies causing them to not gain access to the eggging device. Shortening these curtains at the time the cages are prepared may allow more females to orient to the attractant; thus, increasing the numbers of females on the eggging boards.

Initially the cages that we attempted to egg were 16 hours younger than other production cages. This time was selected after several days of determining the ovarian development of the six oldest groups in the colony. It was thought by eggging the flies at an earlier time the mortality problem and early egg deposition on the cage floor would be eliminated. No significant improvement in grams/cage was determined. We then decided to egg two production cages daily under more controlled conditions. This was accomplished in the Methods Development area. During this time, production began eggging flies eight hours earlier so that one cage we egged was eight hours younger and the second approximately the same age as the cages in production. By carefully preparing the eggging vats, and bringing the oviposition room temperature to near 80° F. and 70 percent RH we were able to increase the grams of eggs/cage to an average of 126 grams. This amounted to about 30 to 40 grams of eggs/cage increase.

Many people had expressed the idea that most of the problems in egg production were related to the strain of screwworm fly currently in production. In the

development of Sinaloa, Dr. C. ~~attempted~~ attempted to incorporate the trait of easier eggging into this strain. During the strain evaluation of Sinaloa in Veracruz, we experienced reasonably good egg production. In order to ascertain if the strain would still produce eggs as found earlier, cages were set up in Methods Development exactly as done last summer. Pupae were taken from the 5 1/2 day room and were not pupae that had been collected for the fly colony. Six liters of pupae were placed in each cage with water and food, adult diet and feeding system developed at Mission, colony temperature of 79° F. and 65 percent RH. These cages produced an average of 174 grams/cage which is identical to the amount of eggs obtained from similar cages last summer. The only difference we found was the eggging time. This was about 16 hours earlier than last summer; however, these flies were subjected to temperatures as high as 85° F. after the air conditioning system failed to work properly. Also, an important finding was that no resorption of yolk was seen in these ovaries. Since the total production of eggs was similar to what we experienced earlier we feel that there is no problem with this strain of fly with regard to egg production at this time.

CONCLUSIONS

First, I feel it is important to maintain adult fly emergence in the colony as close to the same time as possible, i.e., about 7 to 7 1/3 days. At this time, fly colony pupae are held in the 5 1/2 day room. Temperature and humidity data from this room suggest that these are not controlled adequately. Attempting to control the 5 1/2 day room conditions to facilitate proper irradiation time, and adult fly emergence in the distribution centers should not dictate adult emergence in the fly colony. My recommendation is to construct a room of adequate size in which to hold the colony pupae prior to moving these pupae to the colony. A smaller area than the 5 1/2 day room would be easier to control with respect to temperature and humidity. The work that was done in Methods by adjusting the temperature and humidity indicate that an attempt should be made to obtain some type of control of these parameters in the oviposition room. As mentioned earlier, the time to properly prepare the eggging vats prior to placing them into a cage can not be overstated. If these are not ready whenever they go into a cage, the results are obvious. The use of additional eggging boards and their location on the vat has been discussed.

If the procedure of eggging the flies during normal daylight hours is to continue then I feel an adjustment in the eggging time on the shift needs to be changed. Currently the flies eggged at 10:30 are about four to five hours older than the flies eggged at 15:00 and eight to nine hours older than the flies eggged at 19:30. Two things can be done to make these flies more uniform in age: (1) move eggging time of the A group of flies back eight hours so that these insects are more nearly the same age as the B & C groups of flies; or (2) adjust colony pupae collection time so that whenever the flies are moved into the oviposition room all groups are the same age. This difference in age of flies, particularly the first eggging, which are about eight hours older, may reflect the decreased amount of eggs obtained at this time.

Since the flies in cages set up in the Methods colony with the adult diet did not show any symptoms of yolk resorption a closer look must be taken at food quality and availability in the production colony. If the density of the honey can not be controlled, then the means of presenting adequate amounts of this carbohydrate source to the flies needs to be changed.

Finally, everything must be done to reduce the numbers of flies in this colony. It is well documented that increases in fly density reduce egg production; therefore, optimizing all attempts at obtaining eggs from fewer flies is essential. The inability to control elevated temperatures in the pupation, 5 1/2 day room, and fly colony can very well be causing subtle changes in the genetics of this strain of fly. We are all aware of the problems this may cause with the performance of released flies in the field.

Lloyd E. Wendel
Lloyd E. Wendel
Entomologist

~~SECRET~~

~~SECRET~~

PROCEDURES FOR MASS PRODUCTION OF SCREWORMS

The Fly Production Section is staffed with three entomologists, three bio-technicians, five foremen, 15 supervisors, 27 leaders, approximately 217 workers and one clerk-stenographer. The operation is continuous with three eight-hour shifts daily. This is the personnel requirements for maximum production of about 250 million pupae weekly on nutria or 225 million weekly on liquid media.

Employees enter the plant through the security guard entrance. Every employee is assigned a time card on which is stamped the time of entry and exit from the rearing plant. A number is assigned to the card that corresponds with the employee's locker and clothing number. Security regulations, to be discussed later, do not permit wearing street clothing or shoes inside the plant. All clothing is removed in the locker room and the guard unlocks the door to a hallway entrance. At the opposite end of the hallway is the clothing and laundry room where the employee dresses into work clothes and safety shoes. At the end of the 8-hour tour of duty the clothes are washed, dried, and placed in the clothes bin assigned to the employee.

Fly production begins in the adult Fly Colony. The breeding stock is maintained on a 6 1/3 day cycle. Colony cages are stocked with 6-day old pupae and emergence occurs about 24 hours later. After the flies are approximately 5 1/3 days old an oviposition stimulant is used to induce laying. Every eight hours eggs are harvested from eight cages, the flies are then destroyed, cages cleaned and re-stocked with pupae. Colony pupae are taken from the first pupae separated at the beginning of each shift. Four liters of pupae are collected for each colony cage and held in screen bottom trays, two liters per tray at a constant temperature of 73 to 80°F. and 70 percent R.H.

To enter the Fly Colony the employee will pass through two vestibules with three screen doors. This is a security area designed to prevent the escape of flies from the colony. This leads into the cage preparation area. The colony cages are five feet long, five feet eight inches high, and three feet wide with screen on the top and all sides. They are mounted on castors for mobility. First, brown wrapping paper is placed on the floor of the cages. Alternately placed along each side is ten quart jars filled with water and ten pint jars filled with honey. Each of these jars is inverted over a plastic chick water feeder. In the center of the cages are placed two cafeteria type trays containing a mixture of equal parts ground lean meat and honey. To prevent the adult flies from getting trapped in the water in the trays a strip of cotton is placed around the perimeter of the chick water feeder. Also to prevent the flies from getting

stuck in the honey jars and the meat-honey mixture a light cover of cotton and rice hulls are sprinkled on the surface. Suspended from rods near the top of the cage to about one foot from the floor are numerous strips of paper toweling. This toweling serves as resting area and aids in cage sanitation. The pupae holding trays are then placed in top of the cages, resting on the rods that hold the toweling. The door of the cage is now closed and taped to prevent the escape of flies. On the door of each cage is a label showing shift, date and cage number and the same information is recorded in the Fly Colony log book.

The employee will now move this cage into the holding room where the temperature is controlled to 78-79°F and relative humidity of 50 percent. An automatic timer allows 12 hours darkness and 12 hours of light. Emergence will occur within the next 24 hours and after an additional 5 1/3 days the flies are ready to oviposit. At this time the worker will move the cage to a dark oviposition room for the purpose of obtaining eggs. Located at the bottom of the door of the cage is a cloth muslin sleeve. An eggging device which was made ready two hours previously is inserted through the cloth sleeve into the cage where it will remain for an oviposition period of three hours. The eggging device consists of the following sections:

1. This section is an electrically heated aluminum vat, 5 feet long, 12 inches wide and 1½ inches deep.
2. The second section is a sponge rubber pad five feet long, one foot wide and ½ inch thick. This pad is saturated with the oviposition stimulant (a mixture of equal parts water and spent liquid medium.)
3. The third section is the eggging board, made up of several wood slats closed at both ends and rests on top of the sponge rubber.
4. The fourth and last section is a light fixture with three 7.5 watt bulbs placed on top of the eggging board to attract the flies.

The sponge containing the attractant is pre-heated to 95°F before the device is assembled and inserted in the cage. During oviposition the same temperature is maintained by rheostat control.

At the completion of the three hours eggging time, the entire cage will be moved into a temperature knock down reefer (32-35°F). After approximately 15 minutes in this reefer the cold will cause the flies to become inactive so the worker can safely open the door.

of the fly cage. The egging device should be removed first by slowly retracting and at the same time brushing (using a brush) the chilled flies off the device back into the cage. All four sections are now dismantled with the wooden egging board section taken to the egg weighing room for the purpose of removing the eggs. Ninety nine percent of the eggs will be on this section. These eggs are removed with the use of a spatula drawn along the sides of the "wooden slats" as if skinning an animal. After removing the eggs they are weighed into seven gram lots and placed in a petri dish (5 3/4" diameter) that has a moist disk of paper towels in the bottom. For air circulation in the petri dish a wedge of paper is passed over the lip of the bottom part of the dish so the top does not fit air tight. The demand of production dictates the number of 7 grams (petri dishes).

Media Preparation: In this area are two cold storage reefers with a holding capacity of 240,000 pounds of meat. The availability and cost of meat has been prohibitive except for nutria which is seasonal. The quantity this year will operate the production plant for about three months. Liquid media, prepared by reconstituting certain dry products, is used when meat is not available. The cold storage reefers are located in the thawing, grinding and mixing area. Nutria meat is packed in 50 pound paper bags. Each shift will remove about 250 bags, 13,000 pounds, from cold storage, and place on metal thawing racks. The meat is allowed 32 hours to thaw and is then ground, including bone, through a 1/2 inch die. Full production on meat requires about 266,000 pounds of nutria and 20,000 pounds of dry nutrients weekly. In preparing meat media the dry nutrients, blood and suckle milk are first reconstituted with water mechanically in a large cylinder like tank. This mixture is then pumped into large round metal pots and is mechanically mixed with the meat. This accounts for only part of the dry nutrients used. At present, the larvae are being fed for the first 44 hours on reconstituted dry nutrients mixed with cotton. In the past, both meat and liquid media have been prepared with the same equipment in the media preparation room inside the plant. In the future all meat media will continue to be prepared in this area. Beginning in July 1974 all liquid media will be prepared in a newly constructed preparation room outside the plant and the media pumped to the inside.

Rearing on liquid media requires about 77,000 pounds of dry nutrients weekly and 2,000 pounds of meat. This small quantity of meat is required for food in the Fly Colony. After the media is prepared, meat or liquid, is pumped into plastic feeding carts and the worker rolls the carts between the lines of rearing vats.

Composition of Media: A special starting media is used for both meat and liquid media rearing. There are two starting meat diets and one starting liquid diet as follows:

(1)	540 pounds ground meat	60.7%
	21.0 gallons bovine plasma	19.0%
	21.0 gallons water	19.0%
	810 cc formalin 1.0 cc formalin	0.2%
(2)	540 pounds ground meat	71.6%
	25.2 gallons water	25.8%
	16.2 pounds spray dried whole egg	2.1%
	2.7 pounds dried suckle milk	0.3%
	810 cc formalin 1.0 cc formalin	0.2%
(3)	51 gallons water	85.0%
	29.88 pounds dried blood	6.0%
	14.94 pounds dried whole egg	3.0%
	14.94 pounds dried suckle milk	3.0%
	14.94 pounds dried cottage cheese	3.0%
	566 cc formalin	0.25%

The quantity of media in formula one and two is sufficient for 116 starting trays (maximum rearing on meat media). The quantities of media in number three is sufficient for 92 starting trays (maximum rearing on liquid media.) This quantity of liquid media in number three is mixed with 42.28 pounds of number two linters cotton. In liquid media rearing a second starting tray is used which requires twice as much media as shown in formula three. All three starting media can be used for meat rearing on the floor but for liquid rearing on the floor only formula three can be used.

The composition of meat and liquid media for vat rearing on the floor are as follows:

Meat Media

2700 pounds nutria meat	74.37%
135 pounds dried blood	3.73%
27 pounds suckle milk	0.74%
90 gallons water	20.65%
4,050 cc formalin 1.0 cc formalin	0.20%

Liquid Media

322 gallons of water	86.0%
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186.75 pounds dried blood	6.0%
93.37 pounds dried suckle milk	3.0%
93.37 pounds dried whole egg	3.0%
62.25 pounds dried cottage cheese	2.0%
3544 cc formalin	0.25%

This quantity of liquid media when mixed with 200 pounds of cotton is sufficient for filling 50 vats and is the maximum amount for one mixture.

Starting Newly Hatched Larvae:

Each starting tray will be seeded with newly hatched larvae from seven grams of eggs. When rearing at maximum on meat media 116 trays are started every eight hour shift. Only starting room number one is used for the meat diet. The temperature is controlled from 100-103°F and 85-90% R.H.

A measured amount of media (2 liters) is spread evenly in plastic trays 25x17½x3½". After the trays are loaded with media on the rearing floor they are placed in mobile bun racks. Before the newly hatched larvae are infested, the trays (liquid or meat media) are pre-heated for two hours in starting room number one.

After this time the mobile bun racks are rolled back to the area where they were previously loaded with media and the newly hatched larvae are infested in the starting trays (one petri dish with seven grams per tray.) Approximately 30 minutes is required to infest starting trays and then immediately they are rolled back into starting room number one where they will remain for the appropriate time.

First described will be the fresh meat schedule. The fresh meat diet will remain in starting room number one for a minimum of 32 hours. During this 32 hours the worker assigned to this department will make temperature and humidity checks every 30 minutes. These readings are recorded on a chart provided for this purpose. He will also every 30 minutes check on the condition of the larvae, giving special attention to the need of supplementary feedings and to the need of possible addition of water to help control any excessive evaporation of the meat. At the end of the 32 hours (minimum) in the starting room the worker now has that group of larvae ready to be delivered to the next department.

Larvae Rearing Floor No. 1:

The workers assigned to the rearing floor will be working in cooperation with the starting room worker. They will consult with each department as to the hour the larvae will be ready to plant on the rearing floor No. 1. Approximately two hours before planting, the workers will place strips of meat media on both sides of the floor rearing vats. It will be noticed that the meat formula and size of the floor rearing vat have changed. The floor rearing vats have a dimensions of 56x45x1 $\frac{1}{4}$ " and are made of metal. The temperature of these vats is adjusted to 95-98°F by the use of powerstats. When these vats have warmed to the desired temperature, the worker will place strips of media on both sides of the rearing vat to a depth of $\frac{1}{2}$ inch and 8 inches wide. After the worker has finished preparing the vat and it has reached the desired temperature, he will infest each vat with one plastic tray of 32-hour-old larvae. In order to divide the larvae evenly on both sides of the vat, the worker will thoroughly mix the contents of the plastic pan as if he were kneeding bread dough. The worker now can, with consistent accuracy, estimate half of this "ball" of meat and larvae. After dividing this ball into halves, the worker will plant the right side of the rearing vat by carefully molding one-half of this ball along the length of the edge of the vat and strip of fresh media. The left side of the vat will be serviced the same as for the right side of the vat. At this point, the vat has been made ready for the first eight hours on rearing floor No. 1.

Larvae may also be started on the liquid media procedures to be described later, and transferred to meat media on the vats. When this is done the cotton in the plastic starting trays is saturated with water and then vacuumed as dry as possible. Then the cotton with the larvae is sprinkled on top of the meat strips along the outer edges of the vat. Within 16 hours, the larvae will have penetrated into the meat and the cotton can be removed.

Before attempting to explain the feeding schedule of the larvae on rearing floor No. 1 or No. 2, it is important for the worker to understand that the different groups of larvae are fed approximately every eight hours. Each group of vats will remain on floor No. 1 for approximately 32 hours. This, of course, would be four different feedings at eight hour intervals.

After infesting the vat, the workers main concern with this group will be to make spot checks for improper heating, excessive dryness, etc.

The larvae that have been planted on both sides of the vat should feed, as a unit of one, towards the fresh media in the direction

of the center of the rearing vat. It will take approximately eight hours for the larvae to feed into and finish eating the media. At this time the "spent" (used up media) will be removed by hand, taking care not to throw away any of the larvae. The spent media, which has been removed, will be put into troughs and left for a period of approximately one hour. The purpose of this is to allow any larvae that were removed in the spent media a chance to regroup or "pocket". The pockets of larvae are removed from the spent media and put back on the same group of vats from where they were first removed. The spent media will now be vacuumed to the cooking tanks for proper disposal. This group of vats have now been made ready for the second eight hours on the larvae rearing floor No. 1. This eight hour feeding differs from the first feeding in that the media is put completely across the vat after the larvae have been lined up along each side of the rearing vat. This is called first center feeding. Care is to be taken not to have the media over a maximum of $3/4$ inch deep. At greater depths, the larvae tend to waste the media, and money and time would also have been wasted. After an additional eight hours, the two lines of larvae that were on each side of the vat will have once again fed to the center of the vat and at this time the spent media will be once again removed and put in troughs to allow any larvae that were removed to pocket. These pockets will again be returned to their proper age group. The worker once again has this group of vats ready for the third 8-hour feeding or the second center feeding. The larvae are for the third time lined up on each side of the vat and fresh media is again put completely across the vat and smoothed out to a maximum of $3/4$ inch deep. Once again the worker has this group of vats serviced for the next and last eight hours on floor No. 1.

As was stated before, at the end of each eight hours, the larvae will have fed to the center of the vat and once again will have to be serviced. This eight hour servicing will have completed the 32 hours on rearing floor No. 1. At this point, the worker should have noticed that during the 32 hours on floor No. 1 the larvae have been feeding toward the center of the vat. But starting with the last 32 hours (floor No. 2) the larvae will be feeding from the center of the vats to the outer edges. The larvae in a few hours will be mature and ready on their own instinct to leave the rearing vats. By this time the worker will also have noticed the larvae have changed from a whitish-grey color to a pinkish color. In order to prepare the vats for floor No. 2, over the water grates, which is a water conveyor system to transport the mature larvae to the next department, the spent media will be removed and processed as previously described. The larvae now will be shoved to the center of the rearing vats and fresh media put completely around the larvae extending out to all four sides of the vats. This group of vats are now ready to be pushed to rearing floor No. 2.

Rearing Floor No. 2:

On floor No. 2 the feeding schedule differs from floor No. 1. At this time the worker moves up and down the rows of vats and as the larvae need additional media he will put a 6-8 inch strip of media in front of the larvae on each side and ends of the vat. For each additional eight hours the larvae are on floor No. 2, the worker will have observed that the number of larvae on the vats have been decreasing with each passing hour. So as to not waste media, the worker will reduce the amount of media on each side and end of the vat. When this schedule is followed by the time the last few larvae leave the rearing vats also the last of the fresh media will have been consumed. All vats of this group are now finished and are ready to be washed in preparation for another group of larvae coming from the starting room.

In order not to confuse the reader, it should be pointed out at this time that the description of the above has been for a meat media diet. The next few pages will take up the liquid media rearing procedures.

Liquid Rearing

Starting Newly Hatched Larvae:

Each starting tray (maximum production 92 per 8-hour shift) is seeded with newly hatched larvae from seven grams of eggs. When production is geared for the liquid method of rearing screwworms, the starting rooms are regulated for two different conditions. Starting room No. 1 is temperature controlled to 100-103°F and 70-80% R.H. Starting room No. 2 is temperature controlled to 95-98°F and 50-60% R.H. The larvae are started in metal trays 18x13x2" and after 24 hours transferred to plastic trays 25x17½x3½". When rearing on liquid media the larvae have a tendency to crawl up the sides of the trays and may be lost from dessication or crawling out. To prevent this, the inner sides of both trays are moistened and coated with dry powdered egg.

For the first 24 hours in starting room No. 1, the worker makes checks to insure proper room conditions. At the end of 24 hours the larvae are transferred to plastic trays which contain double the amount of liquid media as was required for the first 24 hours. These plastic trays which are in bun racks will remain in room No. 1 for an additional four hours (total 28 hours). After this additional time, these bun racks will be moved into starting room No. 2 where they will remain for 12 to 16 hours or a total of 40 to 44 hours in both

rooms. During the time in the No. 2 room, the worker will also make temperature and humidity checks. These readings are recorded in the proper log book for that room. He will also make checks of the temperature in the cotton-liquid media and will stir the entire contents of the plastic tray in order to release the excess heat. At the end of 40 hours minimum, in starting room No. 1 and No. 2, the worker now has the group of larvae ready to be delivered to the next department.

Larvae Rearing Floor No. 1:

The worker assigned to the rearing floor will be working in cooperation with the starting room worker. They will consult with each department as to the hour the larvae will be ready to plant on rearing floor No. 1. The floor worker will know approximately two hours in advance to load 66 pounds of cotton-liquid mixture to each vat. To each vat the worker will have put four pounds of linters cotton impregnated with $7\frac{1}{2}$ gallons of liquid. This will spread evenly over the entire vat $3\frac{1}{4}$ inch deep. After the worker has finished preparing the vat and it has reached the desired temperature of 95°F , he will infest each vat with one plastic tray of 40-hour-old larvae. Before the plastic tray of larvae is infested on the floor vats, it is washed with warm water and then vacuumed to remove the spent liquid media and wash water. The vacuum head has the dimensions of $12 \times 6 \times 3\frac{1}{4}$ ". The head of the vacuum that is placed on the cotton-liquid is covered with a fine mesh screen so as not to vacuum larvae from the plastic tray. The natural instinct of the larvae is to "dig in" when disturbed. This fact along with the fine mesh screen wire insures little or no loss of larvae. After the worker has washed and vacuumed these plastic trays of larvae, he will re-saturate the cotton with one pint of liquid media and mix the contents of the tray as if kneeding bread dough. The worker will now sprinkle the contents of the plastic tray over the surface of the rearing vat, leaving approximately a three to four inch border around the perimeter of the vat that he does not sprinkle the starting room cotton.

After the worker infests the vat his main concern with that group for the next 16 hours will be to make checks and maintain proper vat temperature (98°F). At the end of two shifts (16 hours) the worker will give that group of larvae a supplementary feeding of one to two pints of liquid media. Beginning with the first 24 hours on the rearing floor No. 1, the group will receive the first vacuuming. This vacuuming should remove a minimum of three gallons of spent liquid media. The worker that is following behind the vacuuming crew will re-saturate the vacuumed vat of cotton and larvae

with three gallons of fresh liquid media. This will reinstate the original $7\frac{1}{2}$ gallons of liquid the rearing vat initially had at the time the larvae were infested on floor No. 1. After saturating the vat with fresh liquid, the worker will also thoroughly mix the entire contents of the floor vat. The purpose of this step is to liberate the excess heat that may have accumulated and also to redistribute the larvae evenly over the vat. When producing screw-worms on liquid media there are ten different age groups on the rearing floor, five groups on floor No. 1 and five groups on floor No. 2. There is also eight hours difference between each group. Starting with group three (24 hours on the floor) the feeding and vacuuming schedule is every four hours or twice per eight hour shift. The vats are vacuumed, resaturated with liquid and the cotton liquid and larvae thoroughly mixed and redistributed over the vat. The time spent on floor No. 1 is 40 hours.

Rearing Floor No. 2:

At this time at the end of group No. 5, they are moved to floor No. 2 where the identical schedule will be continued until they become group No. 7. After 16 hours on floor No. 2 (group No. 7) the operator will start to leave approximately a 10 to 15 inch strip in the center of the vat that will not be resaturated with liquid media but rather will be saturated with water. The remainder of the vat will be re-saturated with liquid media. At this stage of the liquid rearing schedule the larval size will be 62 mg. and the larvae will have started to leave the vats in order to pupate. So as to help coax the larvae toward the sides of the vats, the center strip will be increased with every four hour vacuuming and feeding time. Starting with the last half of group No. 7, the numbers of larvae on the vat will be diminishing with each passing hour and by the time the group has been on rearing floor No. 2 for 40 hours (group No. 10), little or no larvae will remain on the vat. At this time the finished group will be washed and another group started on floor No. 1.

As a matter of information, it should be pointed out the time difference required for a fresh meat diet and a liquid diet versus a live host.

Larvae time on a live host = 168 hours.

Larvae time on fresh meat media = 96-108 hours.

Larvae time on liquid media diet = 120-124 hours.

These hours indicate from the time the egg hatches until the larvae leaves the host or artificial media.

The larvae that have been crawling off the vats on floor No. 2, meat or liquid, have been falling into water ditches. The flowing water in these ditches have been conveying the larvae to the water larvae separation. The worker at this position collects these larvae in groups of three liters. After two or three groups have been collected, these three liter groups of larvae are put into plastic trays which contain eight liters of oak sawdust. The worker then places these plastic trays of larvae in a galvanized rack which is on an overhead monorail. The overhead monorail conveys the rack which contain the plastic trays of sawdust and larvae to the next department called pupation.

Pupation and Separation:

The first section of this department is called the pupation room and is controlled for 80°F and approximately 50% R.H. This room receives all three liter groups of larvae delivered from the water-larvae separator. This room is adjusted (time-clock) so that starting at the entrance of the room to the exit, ten hours will have elapsed and also approximately 80% of the larvae will have pupated. To keep the pupation at this percent or higher the sawdust will only be used to the point that it becomes spoiled. This is approximately three cultures of larvae. After this time the sawdust is burned in the incinerator. At the end of the ten hour pupation time, the trays have reached the exit door and are now ready to separate larvae and pupae from sawdust.

In order to separate the sawdust from the pupae and what few larvae that remain, the worker removes the plastic trays from the monorail and slowly empties the contents of the plastic trays on to a mechanical shaker with a screen bottom. The sawdust readily sifts through the screen and falls into a hopper. The pupae and the few remaining larvae are automatically fed to an endless moving rubber belt which is approximately 50 feet long and 18 inches wide. Covering the length of the belt is a hood like tunnel with fluorescent lights running the length of the tunnel. The purpose of these lights is to encourage the small amount of remaining larvae to crawl away from the pupae and fall into funnels that are placed under the pupae-larvae separator. In order to obtain maximum pupation (99.9%) the larvae that crawl into the funnels are collected every 30 minutes and for the second time are re-measured into three liter groups of larvae and eight liters of oak sawdust. The worker will now put the second run larvae in the four-hour section of the ten-hour pupation room and as the time indicates they will be resifted every four hours until maximum pupation occurs. At this time it would have been noticed that the larvae are in the ten-hour pupation section only one time where as the larvae that fall into the funnels under the pupae-larvae separator could be in the four-hour section one more time before maximum pupation occurs. The total times for both sections of the pupation room is approximately 14 to 18 hours. The

endless rubber belt, as it moves from the mechanical shaker through the light tunnel, will have an elapsed time of 15 minutes. The pupae will then fall into a collecting hopper. Here the worker will measure the pupae into three liter groups for the next department called the $5\frac{1}{2}$ -day pupae holding room.

Pupae Holding:

The worker will pour three liters of pupae into pupae holding trays. These trays have the dimensions of 23x18x2" and the bottom is double screened with 1/8" mesh wire. The worker should take care to evenly spread the pupae over the entire surface of the pupae holding trays. Each tray will be labeled as to date, time, shift, and number of liters of pupae per tray. After the worker has finished loading approximately 18 trays of pupae into bun racks he will move the racks into the holding room. At the entrance to holding room the trays are removed and inserted into racks on an overhead monorail. The racks are manually moved on the monorail until they reach the exit for irradiation. During this time, 5 to $5\frac{1}{2}$ days, the pupae will undergo the necessary development for sterilization. Because of the importance of this room, the worker will make hourly checks and record the reading in the $5\frac{1}{2}$ -day log book. He will inform his duty foreman of any changes in temperature from 78-79°F and R. H. from 70-80%. After the pupae have aged for the proper time and temperature, they will be moved to the next department called canister loading.

Canister Loading:

The worker at this area manually moves the pupae in bun racks from the $5\frac{1}{2}$ -day holding room to the canister loading area. Since there is no temperature control in this area, he will remove no more than an hours supply of pupae. In this area the worker is required to wear a film badge for monitoring radiation. He is also required to follow security procedures, cleaning up of spilled pupae in the loading area and steaming the empty pupae trays in a steam chamber to kill any remaining pupae.

The canister loading worker will log on forms provided at the exit, all pupae removed from the $5\frac{1}{2}$ -day pupae room. Before loading the irradiation canister, each basket of pupae will be vacuumed to remove any dust left over from the sawdust. After the vacuuming, the pupae are ready to load into the irradiation canister. The worker will take special care to load the canister only up to but not over the calibrated line which has been scribed on the outside of the canister. This amount is approximately $3\frac{1}{2}$ liters of pupae. As soon as the worker has loaded the correct amount of pupae in each

canister, a metal lid will be secured to the top. He will use a special metric size wrench which will lock the lid securely in place. The worker will double check to see if the proper amount of pupae has been loaded into the canister and also if the lid has been secured properly. After double checking his work, the loaded canisters are now ready to pass through to the next department called Irradiation. Delivery of the pupae canisters to the Irradiation Department ends the responsibility of the production worker.

Fly Security:

Security is of utmost importance and all employees or visitors must abide by strict regulations to prevent the escape of any viable forms. To control and assist men entering or leaving the plant a security guard is located at the entrance to the plant. Entry of each employee is recorded on a time card. Visitors, other than program, must submit an identity card authorized by the Program Director. The visitor must also sign the visitors log book as to time of entry and exit. After each person has completely undressed the guard will unlock the security door and allow entry to the security area. He will then walk down a hallway past the shower rooms and enter into the dressing room adjacent to the laundry room. Here plant clothing is issued. Upon leaving the plant the employee will return to this area, undress, take a bath towel and proceed to the shower room. A complete shower including a hair rinse is required of everyone. After the shower the employee will return to the security door where he will press a buzzer to alert the guard that he is ready to leave the security area and dress in his street clothing. The guard will unlock the door and visually check each person as he walks into the locker room. There is a separate security entrance for ladies operated under similar procedures.

To prevent flies from emerging in the rearing area or pupation rooms, one worker will continuously inspect these areas and clean up any larvae or pupae found on the floor. The worker at the pupae-larvae separator will have two clean-up periods during his tour of duty. Every four hours the sawdust sifter and pupae conveyor belt will be blown clean with compressed air to prevent the accumulation of older pupae.

In the Fly Colony after the cages are egged, it is required that the flies be destroyed. The worker will sweep the inactive chilled flies into a pile and load these into paper bags along with the strips of paper toweling. The ends of the bags are sealed and then placed in 55 gallon metal drums. After the top of the drum is sealed, it is moved to the hot room where it will remain at 140-150°F

for 24 hours. Then the paper bags and contents are burned in the incinerator.

There are many items used in the process of mass rearing of screw-worms that must leave the plant. The most important of these items is the spent meat media, spent liquid media, used cotton and drainage from the floor. Each time the rearing vats are serviced the spent media is vacuumed into cooking tanks on the outside. There are four cooking tanks, each with a capacity of 3,000 gallons. Two of these are for cooking liquid and the other two for cooking spent nutria media. At the beginning of each shift the tank operator coming on duty will check the records and determine which tank is being cooked and which is on vacuum and filling with meat media or liquid. The tank operator and the supervisor inside the plant coordinate the operation of these tanks. Live steam is fed into the tanks until they reach a minimum temperature of 160°F for one hour and is then cut off allowing another hour to insure that all viable forms are dead. Then the cooked media with bone is pumped into a truck and unloaded in open trenches. The spent liquid media, vacuumed from the cotton and drainage from the floor are cooked in the same manner and pumped into the sewer disposal system. The cotton used in the liquid media rearing is cooked with steam in large cooking pots inside the plant. There is no time interval for cooking. The cotton with liquid is agitated and steam applied until the temperature reaches 210°F to insure kill to any viable forms. Then the cooked cotton is vacuumed into a truck on the outside and disposed of in open trenches.

Garbage that can be burned in the plant incinerator is disposed of by burning. Items such as barrels, pallets, equipment needing repair and equipment no longer needed inside, must spend 24 hours in the hot room at 140 to 150°F. After this period, under the supervision of the security guard, these materials are moved to the outside. Items such as cameras, paper reports, gas containers, tools and small pieces of equipment are sent to the outside through a special pass-through box. Any item that has been authorized to be passed outside must be examined thoroughly by the foreman on duty. All information must be logged on the appropriate form.

Temperatures of the outside media cooking equipment are automatically recorded on charts and are sent to the Entomologist in Charge of Fly Production. The temperature reading from the in-plant cotton cooking tanks are maintained by the foreman and each day sent to the Entomologist in Charge. Materials may enter the plant either through the hot room or the cold storage reefers. When these are to be loaded, the foreman is notified by the guard to lock the inside door. The guard keeps the keys to the outside doors.

On occasion, viable eggs, larvae and pupae are requested by the Screwworm Research and Methods Development Entomologists. On these occasions, strict security procedures are followed. Locked carrying cases are used. One key is held in the Screwworm Research Laboratory and one key inside the production plant. Information is recorded on a special form accompanying the carrying case and records are maintained of every transaction.

